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CHAPTER 1. TOLERANCES AND SPECIFICATIONS FOR COMMERCIAL WEIGHING AND MEASURING DEVICES

Article 1. National Uniformity, Exceptions and Additions

4000. - This section incorporates the adoption, by reference, of the National Institute of Standards and Technology Handbook 44.

NOTE: Authority cited: Sections 12027 and 12107, Business and Professions Code. Reference: Section 12107, Business and Professions Code.

4001. - The following sections of Handbook 44 are not adopted and are annotated "Not Adopted" in the text:

1.10. General Code.

G-S.1.2. Remanufactured Devices and Remanufactured Main Elements.

G.T.1. Acceptance Tolerances.

- (b)
- (c)
- (d)

2.20. Scales.

S.1.8.3. Customer Indications.

N.3. Minimum Test Weights and Test Loads*.

UR.2.6.1. Vehicle Scales.

UR.3.7. Minimum Load on a Vehicle Scale.

3.30. Liquid Measuring Devices.

N.4.1.1. Wholesale Devices Equipped With Automatic Temperature Compensating Systems.

3.31. Vehicle-Tank Meters.

UR.2.2. Ticket Printer; Customer Ticket.

3.32. Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices.

S.2.6. Automatic Temperature Compensation.

N.4.1.1. Automatic Temperature Compensation.

UR.2.3. Vapor Return Line.

3.33. Hydrocarbon Gas Vapor - Measuring Devices.

S.4.3. Temperature Compensation.

Appendix D. Definitions for:

Remanufactured Devices.

Remanufactured Element.

Repaired Devices.

Repaired Element.

NOTE: Authority cited: Sections 12027 and 12107, Business and Professions Code. Reference: Section 12107, Business and Professions Code.

4002. These requirements are different than, or in addition to, the requirements of Handbook 44 and are included in the appropriate section of the text. They are shaded, bordered, and numbered in the 4002 series to differentiate them from the Handbook 44 requirements.

NOTE: Authority cited: Sections 12027 and 12107, Business and Professions Code. Reference: Section 12107, Business and Professions Code.

Section 4002.3. Vehicle-Tank Meters. (3.31.)

UR.2.2. Ticket Printer; Customer Ticket. Vehicle-mounted metering systems shall be equipped with a ticket printer which shall be used for all sales where product is delivered through the meter. A copy of the ticket issued by the device shall be left with the customer at the time of delivery or as otherwise specified by the customer. [Nonretroactive as of January 1, 1995.]

NOTE: Authority cited: Sections 12027 and 12107, Business and Professions Code. Reference: Section 12107, Business and Professions Code.

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Sec. 1.10. General Code

G-A. Application

G-A.1. Commercial and Law-Enforcement Equipment. - These specifications, tolerances, and other technical requirements apply as follows:

- (a) To commercial weighing and measuring equipment; that is, to weights and measures and weighing and measuring devices commercially used or employed in establishing the size, quantity, extent, area, or measurement of quantities, things, produce, or articles for distribution or consumption, purchased, offered, or submitted for sale, hire, or award, or in computing any basic charge or payment for services rendered on the basis of weight or measure.
- (b) To any accessory attached to or used in connection with a commercial weighing or measuring device when such accessory is so designed that its operation affects the accuracy of the device.
- (c) To weighing and measuring equipment in official use for the enforcement of law or for the collection of statistical information by government agencies.

(These requirements should be used as a guide by the weights and measures official when, upon request, courtesy examinations of noncommercial equipment are made.)

G-A.2. Code Application. - This General Code shall apply to all classes of devices as covered in the specific codes. The specific code requirements supersede General Code requirements in all cases of conflict.
(Amended 1972)

G-A.3. Special and Unclassified Equipment. - Insofar as they are clearly appropriate, the requirements and provisions of the General Code and of specific codes apply to equipment failing, by reason of special design or otherwise, to fall clearly within one of the particular equipment classes for which separate codes have been established. With respect to such equipment, code requirements and provisions shall be applied with due regard to the design, intended purpose, and conditions of use of the equipment.

G-A.4. Metric Equipment. - Employment of the weights and measures of the metric system is lawful throughout the United States. These specifications, tolerances, and other requirements shall not be understood or construed as in any way prohibiting the manufacture, sale, or use of equipment designed to give results in terms of metric units. The specific provisions of these requirements and the principles upon which the requirements are based shall be applied to metric equipment insofar as appropriate and practicable. The tolerances on metric

equipment, when not specified herein, shall be equivalent to those specified for similar equipment constructed or graduated in the inch-pound system.

G-A.5. Retroactive Requirements. - “Retroactive” requirements are enforceable with respect to all equipment. Retroactive requirements are printed herein in upright Roman type.

G-A.6. Nonretroactive Requirements. - “Nonretroactive” requirements are enforceable after the effective date for:

- (a) devices manufactured within a State after the effective date;
- (b) both new and used devices brought into a State after the effective date; and
- (c) devices used in noncommercial applications which are placed into commercial use after the effective date.

Nonretroactive requirements are not enforceable with respect to devices that are in commercial service in the State as of the effective date or to new equipment in the stock of a manufacturer or a dealer in the State as of the effective date.
[Nonretroactive requirements are printed in italic type.]
(Amended 1989)

G-A.7. Effective Enforcement Dates of Code Requirements. - Unless otherwise specified, each new or amended code requirement shall not be subject to enforcement prior to January 1 of the year following the adoption by the National Conference on Weights and Measures and publication by the National Institute of Standards and Technology.

G-S. Specifications

G-S.1. Identification. - All equipment, except weights and separate parts necessary to the measurement process but not having any metrological effect, shall be clearly and permanently marked for the purposes of identification with the following information:

- (a) the name, initials, or trademark of the manufacturer or distributor;
- (b) a model designation that positively identifies the pattern or design of the device;
- (c) *the model designation shall be prefaced by the term “Model,” “Type,” or “Pattern.” These terms may be followed by the term “Number” or an abbreviation of that word. The abbreviation for the word “Number” shall, as a minimum, begin with the letter “N” (e.g., No or No.) The abbreviation for the word “Model” shall be “Mod” or “Mod.”*

[Nonretroactive as of January 1, 2003]
(Added 2000) (Amended 2001)

1.10. General Code

[Note: Prefix lettering may be initial capitals, all capitals or all lower case.]

- (d) *except for equipment with no moving or electronic component parts and not built-for-purpose, software-based devices, a nonrepetitive serial number;*
[Nonretroactive as of January 1, 1968]
(Amended 2003)
- (e) *for not built-for-purpose, software-based devices the current software version designation;*
- (f) *the serial number shall be prefaced by words, an abbreviation, or a symbol, that clearly identifies the number as the required serial number;*
[Nonretroactive as of January 1, 1986]
- (g) *the serial number shall be prefaced by the words "Serial Number" or an abbreviation of that term. Abbreviations for the word "Serial" shall, as a minimum, begin with the letter "S," and abbreviations for the word "Number" shall, as a minimum, begin with the letter "N" (e.g., S/N, SN, Ser. No, and S No.; and.*
[Nonretroactive as of January 1, 2001]
- (h) *For devices that have an NTEP Certificate of Conformance (CC), the CC Number or a corresponding CC addendum number, shall be prefaced by the terms "NTEP CC," "CC," or "Approval." These terms may be followed by the term "Number" or an abbreviation of that word. The abbreviation for the word "Number" shall, as a minimum, begin with the letter "N" (e.g., No or No.).*
[Nonretroactive as of January 1, 2003]
(Added 2001)

The required information shall be so located that it is readily observable without the necessity of the disassembly of a part requiring the use of any means separate from the device.
(Amended 1985, 1991, 1999, 2000 and 2003)

G-S.1.1. Location of Marking Information for Not Built-For-Purpose, Software-Based Devices. – *For not built-for-purpose, software-based devices, the following shall apply:*

- (a) *the manufacturer or distributor and the model designation shall be continuously displayed or marked on the device (see note below), or*
- (b) *the Certificate of Conformance (CC) Number shall be continuously displayed or marked on the device (see note below), or*
- (c) *all required information in G-S.1. Identification. (a), (b), (c), (e), and (h) shall be continuously displayed. Alternatively, a clearly identified "view only" System Identification, G-S.1. Identification, or Weights and*

Measures Identification shall be accessible through the "Help" menu. Required information includes that information necessary to identify that the software in the device is the same type that was evaluated.

Note: *Clear instructions for accessing the remaining required G-S.1. information shall be listed on the CC. Required information includes that information necessary to identify that the software in the device is the same type that was evaluated.*

[Nonretroactive as of January 1, 2004]
(Added 2003)

G-S.1.2. Remanufactured Devices and Remanufactured Main Elements.

[NOT ADOPTED]

G-S.2. Facilitation of Fraud. - All equipment and all mechanisms and devices attached thereto or used in connection therewith shall be so constructed, assembled, and installed for use such that they do not facilitate the perpetration of fraud.

G-S.3. Permanence. - All equipment shall be of such materials, design, and construction as to make it probable that, under normal service conditions:

- (a) accuracy will be maintained,
- (b) operating parts will continue to function as intended, and
- (c) adjustments will remain reasonably permanent.

Undue stresses, deflections, or distortions of parts shall not occur to the extent that accuracy or permanence is detrimentally affected.

G-S.4. Interchange or Reversal of Parts. - Parts of a device that may readily be interchanged or reversed in the course of field assembly or of normal usage shall be:

- (a) so constructed that their interchange or reversal will not affect the performance of the device, or
- (b) so marked as to show their proper positions.

G-S.5. Indicating and Recording Elements.

G-S.5.1. General. - All weighing and measuring devices shall be provided with indicating or recording elements appropriate in design and adequate in amount. Primary indications and recorded representations shall be clear, definite, accurate, and easily read under any conditions of normal operation of the device.

G-S.5.2. Graduations, Indications, and Recorded Representations.

G-S.5.2.1. Analog Indication and Representation. Graduations and a suitable indicator shall be provided in connection with indications designed to advance continuously.

G-S.5.2.2. Digital Indication and Representation. Digital elements shall be so designed that:

- (a) All digital values of like value in a system agree with one another.
- (b) A digital value coincides with its associated analog value to the nearest minimum graduation.
- (c) A digital value “rounds off” to the nearest minimum unit that can be indicated or recorded.
- (d) *A digital zero indication includes the display of a zero for all places that are displayed to the right of the decimal point and at least one place to the left. When no decimal values are displayed, a zero shall be displayed for each place of the displayed scale division.*
[Nonretroactive as of January 1, 1986.]
(Amended 1973 and 1985)

G-S.5.2.3. Size and Character. - In any series of graduations, indications, or recorded representations, corresponding graduations and units shall be uniform in size and character. Graduations, indications, or recorded representations that are subordinate to or of a lesser value than others with which they are associated shall be appropriately portrayed or designated.
[Made retroactive as of January 1, 1975.]

G-S.5.2.4. Values. - If graduations, indications, or recorded representations are intended to have specific values, these shall be adequately defined by a sufficient number of figures, words, symbols, or combinations thereof, uniformly placed with reference to the graduations, indications, or recorded representations and as close thereto as practicable, but not so positioned as to interfere with the accuracy of reading.

G-S.5.2.5. Permanence. - Graduations, indications, or recorded representations and their defining figures, words, and symbols shall be of such character that they will not tend easily to become obliterated or illegible.

G-S.5.3. Values of Graduated Intervals or Increments. In any series of graduations, indications, or recorded representations, the values of the graduated intervals or increments shall be uniform throughout the series.

G-S.5.3.1. On Devices That Indicate or Record in More Than One Unit. - On devices designed to indicate or record in more than one unit of measurement, the values indicated and recorded shall be identified with an appropriate word, symbol, or abbreviation.

[Made retroactive 1990.]

(Amended 1978, 1986)

G-S.5.4. Repeatability of Indications. - A device shall be capable of repeating, within prescribed tolerances, its indications and recorded representations. This requirement shall be met irrespective of repeated manipulation of any element of the device in a manner approximating normal usage (including displacement of the indicating elements to the full extent allowed by the construction of the device and repeated operation of a locking or relieving mechanism) and of the repeated performance of steps or operations that are embraced in the testing procedure.

G-S.5.5. Money Values, Mathematical Agreement. - Any recorded money value and any digital money-value indication on a computing-type weighing or measuring device used in retail trade shall be in mathematical agreement with its associated quantity representation or indication to the nearest 1 cent of money value. This does not apply to auxiliary digital indications intended for the operator’s use only, when these indications are obtained from existing analog customer indications that meet this requirement.

(Amended 1973)

G-S.5.6. Recorded Representations. - Insofar as they are appropriate, the requirements for indicating and recording elements shall be applicable also to recorded representations. All recorded values shall be printed digitally.

[Made retroactive 1990.]

(Amended 1975)

1.10. General Code

Table 1. Representation of Units				
Name of Unit	International Symbol (common use symbol)	Representation		
		Form I	Form II	
		(double case)	(single case lower)	(single case upper)
Base SI units				
Meter	M	M	m	M
Kilogram	Kg	Kg	kg	KG
Derived SI units				
Newton	N	N	n	N
Pascal	Pa	Pa	pa	PA
Watt	W	W	w	W
Volt	V	V	v	V
degree Celsius	°C	°C	°c	°C
Other units				
liter	l or L	L	L	L
gram	G	G	g	G
metric ton	t	t	tne	TNE
bar	Bar	Bar	bar	BAR

G-S.5.6.1. Recorded Representation of Metric Units Equipment with Limited Character Sets. -

The appropriate defining symbols are shown in Table 1.

(Added 1977)

A device may be fitted with an automatic or a semiautomatic calibration mechanism. This mechanism shall be incorporated inside the device. After sealing, neither the mechanism nor the calibration process shall facilitate fraud.

(Added 1985) (Amended 1989, 1993)

G-S.5.7. Magnified Graduations and Indications. - All requirements for graduations and indications apply to a series of graduations and an indicator magnified by an optical system or as magnified and projected on a screen.

G-N. Notes

G-S.6. Marking Operational Controls, Indications, and Features. - All operational controls, indications, and features, including switches, lights, displays, pushbuttons, and other means, shall be clearly and definitely identified. The use of approved pictograms or symbols shall be acceptable.

[Nonretroactive as of January 1, 1977.]

(Amended 1978, 1995)

G-S.7. Lettering. - All required markings and instructions shall be distinct and easily readable and shall be of such character that they will not tend to become obliterated or illegible.

G-S.8. Provision for Sealing Electronic Adjustable Components. - A device shall be designed with provision(s) for applying a security seal that must be broken, or for using other approved means of providing security (e.g., data change audit trail available at the time of inspection), before any change that detrimentally affects the metrological integrity of the device can be made to any electronic mechanism.

[Nonretroactive as of January 1, 1990.]

G-N.1. Conflict of Laws and Regulations. - If any particular provisions of these specifications, tolerances, and other requirements are found to conflict with existing State laws, or with existing regulations or local ordinances relating to health, safety, or fire prevention, the enforcement of such provisions shall be suspended until conflicting requirements can be harmonized; and such suspension shall not affect the validity or enforcement of the remaining provisions of these specifications, tolerances, and other requirements.

G-N.2. Testing With Nonassociated Equipment. - Tests to determine conditions, such as radio frequency interference (RFI), that may adversely affect the performance of a device shall be conducted with equipment and under conditions that are usual and customary with respect to the location and use of the device.

(Added 1976)

G-T. Tolerances

G-T.1. Acceptance Tolerances. - Acceptance tolerances shall apply to:

- (a) equipment to be put into commercial use for the first time;

(b) [NOT ADOPTED]

(c) [NOT ADOPTED]

(d) [NOT ADOPTED]

(e) equipment undergoing type evaluation.
(Amended 1989)

G-T.2. Maintenance Tolerances. - Maintenance tolerances shall apply to equipment in actual use, except as provided in G-T.1.

G-T.3. Application. - Tolerances “in excess” and tolerances “in deficiency” shall apply to errors in excess and to errors in deficiency, respectively. Tolerances “on overregistration” and tolerances “on underregistration” shall apply to errors in the direction of overregistration and of underregistration, respectively. (See Definitions section.)

G-T.4. For Intermediate Values. - For a capacity, indication, load, value, etc., intermediate between two capacities, indications, loads, values, etc., listed in a table of tolerances, the tolerances prescribed for the lower capacity, indication, load, value, etc., shall be applied.

G-UR. User Requirements

G-UR.1. Selection Requirements.

4002.1. General Code (1.10.)

(a) Type Approval Use. Upon written authorization of the Secretary, a county sealer may allow a device to be used for commercial purposes during a type approval inspection period following initial testing.

G-UR.1.1. Suitability of Equipment. - Commercial equipment shall be suitable for the service in which it is used with respect to elements of its design, including but not limited to its weighing capacity (for weighing devices), its computing capability (for computing devices), its rate of flow (for liquid-measuring devices), the character, number, size, and location of its indicating or recording elements, and the value of its smallest unit and unit prices.
(Amended 1974)

G-UR.1.2. Environment. - Equipment shall be suitable for the environment in which it is used including but not limited to the effects of wind, weather, and RFI.
(Added 1976)

G-UR.1.3. Liquid-Measuring Devices. - To be suitable for its application, the minimum delivery for liquid-measuring devices shall be no less than 100 divisions, except that the minimum delivery for retail analog devices shall be no less than 10 divisions. Maximum division values and tolerances are stated in the specific codes.

(Added 1995)

G-UR.2. Installation Requirements.

G-UR.2.1. Installation. - A device shall be installed in accordance with the manufacturer’s instructions, including any instructions marked on the device. A device installed in a fixed location shall be so installed that neither its operation nor its performance will be adversely affected by any characteristic of the foundation, supports, or any other detail of the installation.

G-UR.2.1.1. Visibility of Identification. - Equipment shall be installed in such a manner that all required markings are readily observable.
(Added 1978)

G-UR.2.2. Installation of Indicating or Recording Element. - A device shall be so installed that there is no obstruction between a primary indicating or recording element and the weighing or measuring element; otherwise there shall be convenient and permanently installed means for direct communication, oral or visual, between an individual located at a primary indicating or recording element and an individual located at the weighing or measuring element. [See also G-UR.3.3.]

G-UR.2.3. Accessibility for Inspection, Testing, and Sealing Purposes. - A device shall be located, or such facilities for normal access thereto shall be provided, to permit:

- (a) inspecting and testing the device;
- (b) inspecting and applying security seals to the device; and
- (c) readily bringing the testing equipment of the weights and measures official to the device by customary means and in the amount and size deemed necessary by such official for the proper conduct of the test.

Otherwise, it shall be the responsibility of the device owner or operator to supply such special facilities, including such labor as may be needed to inspect, test, and seal the device, and to transport the testing equipment to and from the device, as required by the weights and measures official.
(Amended 1991)

1.10. General Code

G-UR.3. Use Requirements.

G-UR.3.1. Method of Operation. - Equipment shall be operated only in the manner that is obviously indicated by its construction or that is indicated by instructions on the equipment.

G-UR.3.2. Associated and Nonassociated Equipment.
A device shall meet all performance requirements when associated or nonassociated equipment is operated in its usual and customary manner and location.
(Added 1976)

G-UR.3.3. Position of Equipment. - A device or system equipped with a primary indicating element and used in direct sales, except for prescription scales, shall be so positioned that its indications may be accurately read and the weighing or measuring operation may be observed from some reasonable "customer" and "operator" position. The permissible distance between the equipment and a reasonable customer and operator position shall be determined in each case upon the basis of the individual circumstances, particularly the size and character of the indicating element.
(Amended 1974 and 1998)

G-UR.3.4. Responsibility, Money-Operated Devices. - Money-operated devices other than parking meters shall have clearly and conspicuously displayed thereon, or immediately adjacent thereto, adequate information detailing the method for the return of monies paid when the product or service cannot be obtained. This information shall include the name, address, and phone number of the local responsible party for the device. This requirement does not apply to devices at locations where employees are present and responsible for resolving any monetary discrepancies for the customer.
(Amended 1977, 1993)

G-UR.4. Maintenance Requirements.

G-UR.4.1. Maintenance of Equipment. - All equipment in service and all mechanisms and devices attached thereto or used in connection therewith shall be continuously maintained in proper operating condition throughout the period of such service. Equipment in service at a single place of business found to be in error predominantly in a direction favorable to the device user shall not be considered "maintained in a proper operating condition."
(Amended 1973, 1991)

G-UR.4.2. Abnormal Performance. - Unstable indications or other abnormal equipment performance observed during operation shall be corrected and, if necessary, brought to the attention of competent service personnel.
(Added 1976)

G-UR.4.3. Use of Adjustments. - Weighing elements and measuring elements that are adjustable shall be adjusted only to correct those conditions that such elements are designed to control, and shall not be adjusted to compensate for defective or abnormal installation or accessories or for badly worn or otherwise defective parts of the assembly. Any faulty installation conditions shall be corrected, and any defective parts shall be renewed or suitably repaired, before adjustments are undertaken. Whenever equipment is adjusted, the adjustments shall be so made as to bring performance errors as close as practicable to zero value.

G-UR.4.4. Assistance in Testing Operations. - If the design, construction, or location of any device is such as to require a testing procedure involving special equipment or accessories or an abnormal amount of labor, such equipment, accessories, and labor shall be supplied by the owner or operator of the device as required by the weights and measures official.

G-UR.4.5. Security Seal. - A security seal shall be appropriately affixed to any adjustment mechanism designed to be sealed.

G-UR.4.6. Testing Devices at a Central Location.

- (a) When devices in commercial service require special test facilities, or must be removed from service for testing, or are routinely transported for the purpose of use (e.g., vehicle-mounted devices and devices used in multiple locations), the official with statutory authority may require that the devices be brought to a central location for testing. The dealer or owner of these devices shall provide transportation of the devices to and from the test location.
- (b) When the request for removal and delivery to a central test location involves devices used in submetering (e.g., electric, hydrocarbon vapor, or water meters), the owner or operator shall not interrupt the utility service to the customer or tenant except for the removal and replacement of the device. Provisions shall be made by the owner or operator to minimize inconvenience to the customer or tenant. All replacement or temporary meters shall be tested and sealed by a weights and measure official or bear a current, valid approval seal prior to use.
(Added 1994)

Sec. 2.20. Scales

A. Application

A.1. General. - This code applies to all types of weighing devices other than automatic bulk-weighing systems and belt-conveyor scales. The code comprises requirements that are generally applicable to all weighing devices, and specific requirements that are applicable only to certain types of weighing devices.
(Amended 1972 and 1983)

A.2. Wheel-Load Weighers, Portable Axle-Load Weighers, and Axle-Load Scales. - The requirements for wheel-load weighers, portable axle-load weighers, and axle-load scales apply only to such scales in official use for the enforcement of traffic and highway laws or for the collection of statistical information by government agencies.

A.3. Also see General Code requirements.

S. Specifications

S.1. Design of Indicating and Recording Elements and of Recorded Representations.

S.1.1. Zero Indication.

- (a) On a scale equipped with indicating or recording elements, provision shall be made to either indicate or record a zero-balance condition.
- (b) On an automatic-indicating scale or balance indicator, provision shall be made to indicate or record an out-of-balance condition on both sides of zero.
- (c) A zero-balance condition may be indicated by other than a continuous digital zero indication, provided that an effective automatic means is provided to inhibit a weighing operation or to return to a continuous digital indication when the scale is in an out-of-balance condition.
(Added 1987)
(Amended 1987, 1993)

S.1.1.1. Digital Indicating Elements.

- (a) A digital zero indication shall represent a balance condition that is within $\pm 1/2$ the value of the scale division.
- (b) *A digital indicating device shall either automatically maintain a "center-of-zero" condition to $\pm 1/4$ scale division or less, or have an auxiliary or*

supplemental "center-of-zero" indicator that defines a zero-balance condition to $\pm 1/4$ of a scale division or less.

[Nonretroactive as of January 1, 1993.]
(Amended 1992)

S.1.1.2. No-Load Reference Value. - On a single draft manually operated receiving hopper scale installed below grade, used to receive grain, and utilizing a no-load reference value, provision shall be made to indicate and record the no-load reference value prior to the gross load value.
(Added 1983)

S.1.2. Value of Scale Division Units. - *Except for batching scales and weighing systems used exclusively for weighing in predetermined amounts, the value of a scale division "d" expressed in a unit of weight shall be equal to:*

- (a) *1, 2, or 5; or*
- (b) *a decimal multiple or submultiple of 1, 2, or 5;*
- (c) *a binary submultiple of a specific unit of weight.*

Examples: Scale divisions may be 0.01, 0.02, 0.05; 0.1, 0.2, or 0.5; 1, 2, or 5; 10, 20, 50, or 100; or, scale divisions may be 1/2, 1/4, 1/8, 1/16, etc.
[Nonretroactive as of January 1, 1986.]

S.1.2.1. Weight Units. - *Except for postal scales, a digital-indicating scale shall indicate weight values using only a single unit of measure. Weight values shall be presented in a decimal format with the value of the scale division expressed as 1, 2, or 5, or a decimal multiple or submultiple of 1, 2, or 5.*
[Nonretroactive and enforceable as of January 1, 1989.]
(Added 1987)

S.1.2.2. Verification Scale Interval.

S.1.2.2.1. Class I and II Scales and Dynamic Monorail Scales. If $e \neq d$, the verification scale interval "e" shall be determined by the expression:

$$d < e \leq 10 d$$

If the displayed division (d) is less than the verification division (e), then the verification division shall be less than or equal to 10 times the displayed division.

2.20. Scales

The value of e must satisfy the relationship, $e = 10^k$ of the unit of measure, where k being a positive or negative whole number or zero. This requirement does not apply to a Class I device with $d < 1$ mg where $e = 1$ mg. If $e \neq d$, the value of “ d ” shall be a decimal submultiple of “ e ,” and the ratio shall not be more than 10:1. If $e \neq d$, and both “ e ” and “ d ” are continuously displayed during normal operation, then “ d ” shall be differentiated from “ e ” by size, shape, color, etc., throughout the range of weights displayed as “ d .” (Added 1999)

S.1.2.2.2. Class III and IIII. The value of “ e ” is specified by the manufacturer as marked on the device. Except for dynamic monorail scales, “ e ” must be less than or equal to “ d .” (Added 1999)

S.1.2.3. Prescription Scale with a Counting Feature. – A Class I or Class II prescription scale with an operational counting feature shall not calculate a piece weight or total count unless the sample used to determine the individual piece weight meets the following conditions:

- (a) minimum individual piece weight is greater than or equal to $3e$; and
 - (b) minimum sample piece count is greater than or equal to 10 pieces.
- (Added 2003)

S.1.3. Graduations.

S.1.3.1. Length. - Graduations shall be so varied in length that they may be conveniently read.

S.1.3.2. Width. - In any series of graduations, the width of a graduation shall in no case be greater than the width of the clear space between graduations. The width of main graduations shall be not more than 50 percent greater than the width of subordinate graduations. Graduations shall be not less than 0.2 mm (0.008 in) wide.

S.1.3.3. Clear Space Between Graduations. - The clear space between graduations shall be not less than 0.5 mm (0.02 in) for graduations representing money values, and not less than 0.75 mm (0.03 in) for other graduations. If the graduations are not parallel, the measurement shall be made:

- (a) along the line of relative movement between the graduations at the end of the indicator, or
- (b) if the indicator is continuous, at the point of widest separation of the graduations.

S.1.4. Indicators.

S.1.4.1. Symmetry. - The index of an indicator shall be of the same shape as the graduations, at least throughout that portion of its length associated with the graduations.

S.1.4.2. Length. - The index of an indicator shall reach to the finest graduations with which it is used, unless the indicator and the graduations are in the same plane, in which case, the distance between the end of the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 1.0 mm (0.04 in).

S.1.4.3. Width. - The width of the index of an indicator in relation to the series of graduations with which it is used shall be not greater than:

- (a) *the width of the narrowest graduation,*
[Nonretroactive as of January 1, 2002.]
- (b) the width of the clear space between weight graduations, and
- (c) three-fourths of the width of the clear space between money value graduations.

When the index of an indicator extends along the entire length of a graduation, that portion of the index of the indicator that may be brought into coincidence with the graduation shall be of the same width throughout the length of the index that coincides with the graduation.

S.1.4.4. Clearance. - The clearance between the index of an indicator and the graduations shall in no case be more than 1.5 mm (0.06 in).

S.1.4.5. Parallax. - Parallax effects shall be reduced to the practicable minimum.

S.1.5. Weighbeams.

S.1.5.1. Normal Balance Position. - The normal balance position of the weighbeam of a beam scale shall be horizontal.

S.1.5.2. Travel. - The weighbeam of a beam scale shall have equal travel above and below the horizontal. The total travel of the weighbeam of a beam scale in a trig loop or between other limiting stops near the weighbeam tip shall be not less than the minimum travel shown in Tables 1M and 1. When such limiting stops are not provided, the total travel at the weighbeam tip shall be not less than 8 percent of the distance from weighbeam fulcrum to the weighbeam tip.

Table 1M. Minimum Travel of Weighbeam of Beam Scale Between Limiting Stops	
Distance from weighbeam fulcrum to limiting stops (centimeters)	Minimum travel between limiting stops (millimeter)
30 or less	10
30+ to 50, inclusive	13
50+ to 100, inclusive	18
Over 100	23

Table 1. Minimum Travel of Weighbeam of Beam Scale Between Limiting Stops	
Distance from weighbeam fulcrum to limiting stops (inches)	Minimum travel Between limiting stops (inch)
12 or less	0.4
12+ to 20, inclusive	0.5
20+ to 40, inclusive	0.7
Over 40	0.9

S.1.5.3. Subdivision. - A subdivided weighbeam bar shall be subdivided by scale division graduations, notches, or a combination of both. Graduations on a particular bar shall be of uniform width and perpendicular to the top edge of the bar. Notches on a particular bar shall be uniform in shape and dimensions and perpendicular to the face of the bar. When a combination of graduations and notches is employed, the graduations shall be positioned in relation to the notches to indicate notch values clearly and accurately.

S.1.5.4. Readability. - A subdivided weighbeam bar shall be so subdivided and marked, and a weighbeam poise shall be so constructed, that the weight corresponding to any normal poise position can easily and accurately be read directly from the beam, whether or not provision is made for the optional recording of representations of weight.

S.1.5.5. Capacity. - On an automatic-indicating scale having a nominal capacity of 15 kg (30 lb) or less and used for direct sales to retail customers:

- (a) the capacity of any weighbeam bar shall be a multiple of the reading-face capacity,

- (b) each bar shall be subdivided throughout or shall be subdivided into notched intervals, each equal to the reading-face capacity; and

- (c) the value of any turnover poise shall be equal to the reading-face capacity

S.1.5.6. Poise Stop. - Except on a steelyard with no zero graduation, a shoulder or stop shall be provided on each weighbeam bar to prevent a poise from traveling and remaining back of the zero graduation.

S.1.6. Paises.

S.1.6.1. General. - No part of a poise shall be readily detachable. A locking screw shall be perpendicular to the longitudinal axis of the weighbeam and shall not be removable. Except on a steelyard with no zero graduation, a poise shall not be readily removable from a weighbeam. The knife edge of a hanging poise shall be hard and sharp and so constructed as to allow the poise to swing freely on the bearing surfaces in the weighbeam notches.

S.1.6.2. Adjusting Material. - The adjusting material in a poise shall be securely enclosed and firmly fixed in position; if softer than brass, it shall not be in contact with the weighbeam.

S.1.6.3. Pawl. - A poise, other than a hanging poise, on a notched weighbeam bar shall have a pawl that will seat the poise in a definite and correct position in any notch, wherever in the notch the pawl is placed, and hold it there firmly and without appreciable movement. The dimension of the tip of the pawl that is transverse to the longitudinal axis of the weighbeam shall be at least equal to the corresponding dimension of the notches.

S.1.6.4. Reading Edge or Indicator. - The reading edge or indicator of a poise shall be sharply defined, and a reading edge shall be parallel to the graduations on the weighbeam.

S.1.7. Capacity Indication, Weight Ranges, and Unit Weights.

- (a) **Gross Capacity.** An indicating or recording element shall not display nor record any values when the total platform load (not counting the initial dead load that has been canceled by an initial zero-setting mechanism) is in excess of 105 percent of scale capacity.

- (b) **Capacity Indication.** *Electronic computing scales (excluding postal scales and weight classifiers) shall neither display nor record a gross or net weight in excess of scale capacity plus 9d.*

2.20. Scales

The total value of weight ranges and of unit weights in effect or in place at any time shall automatically be accounted for on the reading face and on any recorded representation.

This requirement does not apply to: (1) single-revolution dial scales, (2) multi-revolution dial scales not equipped with unit weights, (3) scales equipped with two or more weighbeams, nor (4) devices that indicate mathematically derived totaled values.

[Nonretroactive as of January 1, 1993.]
(Amended 1990, 1992, and 1995)

S.1.8. Computing Scales.

S.1.8.1.M. Money-Value Graduations, Metric Unit Prices. - The value of the graduated intervals representing money values on a computing scale with analog indications shall not exceed:

- (a) 1 cent at all unit prices of 55 cents per kilogram and less;
- (b) 2 cents at unit prices of 56 cents per kilogram through \$2.75 per kilogram (special graduations defining 5-cent intervals may be employed but not in the spaces between regular graduations);
- (c) 5 cents at unit prices of \$2.76 per kilogram through \$7.50 per kilogram; or
- (d) 10 cents at unit prices above \$7.50 per kilogram.

Value figures and graduations shall not be duplicated in any column or row on the graduated chart. (See also S.1.8.2.)

S.1.8.1. Money-Value Graduations, Inch-Pound Unit Prices. - The value of the graduated intervals representing money values on a computing scale with analog indications shall not exceed:

- (a) 1 cent at all unit prices of 25 cents per pound and less;
- (b) 2 cents at unit prices of 26 cents per pound through \$1.25 per pound (special graduations defining 5-cent intervals may be employed but not in the spaces between regular graduations);
- (c) 5 cents at unit prices of \$1.26 per pound through \$3.40 per pound; or
- (d) 10 cents at unit prices above \$3.40 per pound.

Value figures and graduations shall not be duplicated in any column or row on the graduated chart. (See also S.1.8.2.)

S.1.8.2. Money-Value Computation. - A computing scale with analog quantity indications used in retail trade may compute and present digital money values to the nearest quantity graduation when the value of the minimum graduated interval is 0.005 kg (0.01 lb) or less. (Also see Sec. 1.10; G-S.5.5.)

S.1.8.3. Customer's Indications.

[NOT ADOPTED]

4002.2. Scales (2.20.)

(e) Customer's Indications. Weight indications shall be shown on the customer's side of computing scales when these are used for direct sales to retail customers. Computing scales equipped on the operator's side with digital indications, such as the net weight, unit price, or total price, shall be similarly equipped on the customer's side. *Unit price displays visible to the customer shall be in terms of whole units of weight, and not in common or decimal fractions.*

[Nonretroactive May 9, 1996.]

S.1.8.3.1. Scales that will function as either a normal round off scale or as a weight classifier shall be provided with a sealable means for selecting the mode of operation and shall have a clear indication (annunciator), adjacent to the weight display on both the operator's and customer's side whenever the scale is operating as a weight classifier.

[Nonretroactive as of January 1, 2001]
(Added 1999)

S.1.8.4. Recorded Representations, Point of Sale Systems. - The sales information recorded by cash registers when interfaced with a weighing element shall contain the following information for items weighed at the checkout stand:

- (a) the net weight,¹
- (b) the unit price,¹

¹ Weight values shall be identified by kilogram, kg, grams, g, ounces, oz, pound, lb, or the sign "#." For devices interfaced with scales indicating in metric units, the unit price may be expressed in price per 100 grams.
(Amended 1995)

- (c) the total price, and
- (d) the product class or, in a system equipped with price look-up capability, the product name or code number.

S.1.9. Prepackaging Scales.

S.1.9.1. Value of the Scale Division. - On a prepackaging scale, the value of the intervals representing weight values shall be uniform throughout the entire reading face. The recorded weight values shall be identical with those on the indicator.

S.1.9.2. Label Printer. - A prepackaging scale or a device that produces a printed ticket to be used as the label for a package shall print all values digitally and of such size, style of type, and color as to be clear and conspicuous on the label.

S.1.10. Adjustable Components. - An adjustable component such as a pendulum, spring, or potentiometer shall be held securely in adjustment and, except for a zero-load balance mechanism, shall be located within the housing of the element.
(Added 1986)

S.1.11. Provision for Sealing.

- (a) *Except on Class I scales, provision shall be made for applying a security seal in a manner that requires the security seal to be broken before an adjustment can be made to any component affecting the performance of*

an electronic device.

[Nonretroactive as of January 1, 1979.]

- (b) *Except on Class I scales, a device shall be designed with provision(s) for applying a security seal that must be broken, or for using other approved means of providing security (e.g., data change audit trail available at the time of inspection), before any change that detrimentally affects the metrological integrity of the device can be made to any electronic mechanism.*

[Nonretroactive as of January 1, 1990.]

- (c) *Except on Class I scales, audit trails shall use the format set forth in Table S.1.11.*

[Nonretroactive as of January 1, 1995.]

A device may be fitted with an automatic or a semi-automatic calibration mechanism. This mechanism shall be incorporated inside the device. After sealing, neither the mechanism nor the calibration process shall facilitate fraud.

(Amended 1989, 1991, 1993)

S.1.12. Manual Gross Weight Entries. - *A device shall accept an entry of a manual gross weight value only when the scale is at gross load zero and the scale indication is zero in the gross weight display mode. Recorded manual weight entries, except those on labels generated for packages of standard weights, shall identify the weight value as a manual weight entry by one of the following terms: "Manual Weight," "Manual Wt," or "MAN WT." The use*

Table S.1.11. Categories of Device and Methods of Sealing	
Categories of Device	Method of Sealing
Category 1: No remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 2: Remote configuration capability, but access is controlled by physical hardware. Device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode.	The hardware enabling access for remote communication must be at the device and sealed using a physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password).	An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to ten times the number of sealable parameters in the device, but not more than 1000 records are required. (Note: Does not require 1000 changes to be stored for each parameter.)

[Nonretroactive as of January 1, 1995.]

(Table added 1993)

2.20. Scales

of a symbol to identify multiple manual weight entries on a single document is permitted, provided that the symbol is defined on the same page on which the manual weight entries appear and the definition of the symbol is automatically printed by the recording element as part of the document.

[Nonretroactive as of January 1, 1993.]

(Added 1992)

S.1.13. Vehicle On-Board Weighing Systems: Vehicle in Motion. - When the vehicle is in motion, a vehicle on-board weighing system shall either:

- (a) be accurate; or
 - (b) inhibit the weighing operation.
- (Added 1993)

S.2. Design of Balance, Tare, Level, Damping, and Arresting Mechanisms.

S.2.1. Zero-Load Adjustment.

S.2.1.1. General. - A scale shall be equipped with means by which the zero-load balance may be adjusted. Any loose material used for this purpose shall be enclosed so that it cannot shift in position and alter the balance condition of the scale.

S.2.1.2. Scales Used in Direct Sales. - A manual zero-setting mechanism (except on a digital scale with an analog zero-adjustment mechanism with a range of not greater than one scale division) shall be operable or accessible only by a tool outside of and entirely separate from this mechanism, or it shall be enclosed in a cabinet. Except on Class I or II scales, a balance ball shall either meet this requirement or not itself be rotatable.

A semiautomatic zero-setting mechanism shall be operable or accessible only by a tool outside of and separate from this mechanism or it shall be enclosed in a cabinet, or it shall be operable only when the indication is stable within:

- (a) plus or minus 3 scale divisions for scales of more than 2 000 kg (5 000 lb) capacity in service prior to January 1, 1981, and for all axle-load, railway track, and vehicle scales; or
- (b) plus or minus 1 scale division for all other scales.

S.2.1.3. Scales Equipped With an Automatic Zero-Setting Mechanism. - *Under normal operating conditions the maximum load that can be "rezeroed," when either placed on or removed from the platform all at once, shall be:*

(a) for bench, counter, and livestock scales: 0.6 scale division;

(b) for vehicle, axle-load, and railway track scales: 3.0 scale divisions; and

(c) for all other scales: 1.0 scale division.

[Nonretroactive and enforceable as of January 1, 1981.]

S.2.1.3.1. Automatic Zero-Setting Mechanism on Class III L Devices - *Class III L devices equipped with automatic zero setting mechanisms shall be designed with a sealable means to allow the automatic zero setting to be disabled during the inspection and test of the device.*
[Nonretroactive as of January 1, 2001]
(Added 1999)

S.2.1.4. Monorail Scales. - On a static monorail scale equipped with digital indications, means shall be provided for setting the zero-load balance to within 0.02 percent of scale capacity. On a dynamic monorail weighing system, means shall be provided to automatically maintain these conditions.
(Amended 1999)

S.2.1.5. Initial Zero-Setting Mechanism.

- (a) Scales of accuracy Classes I, II, and III may be equipped with an initial zero-setting device.
 - (b) An initial zero-setting mechanism shall not zero a load in excess of 20 percent of the maximum capacity of the scale unless tests show that the scale meets all applicable tolerances for any amount of initial load compensated by this device within the specified range.
- (Added 1990)

S.2.1.6. Combined Zero-Tare ("O/T") Key. - Scales not intended to be used in direct sales applications may be equipped with a combined zero and tare function key, provided that the device is clearly marked as to how the key functions. The device must also be clearly marked on or adjacent to the weight display with the statement "Not for Direct Sales."
(Added 1998)

S.2.2. Balance Indicator. - On a balance indicator consisting of two indicating edges, lines, or points, the ends of the indicators shall be sharply defined. When the scale is in balance, the ends shall be separated by not more than 1.0 mm (0.04 in).

S.2.2.1. Dairy-Product-Test, Grain-Test, Prescription, and Class I and II Scales. – Except on digital indicating devices, a dairy-product-test, grain-test, prescription, or Class I or II scale shall be equipped with a balance indicator. If an indicator and a graduated scale are not in the same plane, the clearance between the indicator and the graduations shall be not more than 1.0 mm (0.04 in).

S.2.2.2. Equal-Arm Scale. - *An equal-arm scale shall be equipped with a balance indicator. If the indicator and balance graduation are not in the same plane, the clearance between the indicator and the balance graduation shall be not more than 1.0 mm (0.04 in). [Nonretroactive as of January 1, 1989.]*
(Added 1988)

S.2.3. Tare. - *On any scale (except a monorail scale equipped with digital indications), the value of the tare division shall be equal to the value of the scale division.* The tare mechanism shall operate only in a backward direction (that is, in a direction of underregistration) with respect to the zero-load balance condition of the scale. A device designed to automatically clear any tare value shall also be designed to prevent the automatic clearing of tare until a complete transaction has been indicated.**
(Amended 1985)

*[Note: On a computing scale, this requires the input of a unit price, the display of the unit price, and a computed positive total price at a readable equilibrium. Other devices require a complete weighing operation, including tare, net, and gross weight determination.]**
*[*Nonretroactive as of January 1, 1983.]*

S.2.3.1. Monorail Scales Equipped with Digital Indications. - On a static monorail weighing system equipped with digital indications, means shall be provided for setting any tare value of less than 5 percent of the scale capacity to within 0.02 percent of scale capacity. On a dynamic monorail weighing system, means shall be provided to automatically maintain this condition.
(Amended 1999)

S.2.4. Level-Indicating Means. - Except for portable wheel-load weighers and portable axle-load scales, a portable scale shall be equipped with level-indicating means if its weighing performance is changed by an amount greater than the appropriate acceptance tolerance when it is moved from a level position and rebalanced in a position that is out-of-level in any upright direction by 5 percent (approximately 3 degrees). The level-indicating means shall be readable without removing any scale parts requiring a tool.

[This requirement is nonretroactive and enforceable as of January 1, 1986, for prescription, jewelers', and dairy-product-test scales and scales marked I and II.]

[Note: Portable wheel-load weighers and portable axle-load scales shall be accurate when placed out-of-level up to and including 5 percent (approximately 3 degrees).]
(Amended 1991)

S.2.4.1. Vehicle On-Board Weighing Systems. - A vehicle on-board weighing system shall operate within tolerance when the weighing system is out-of-level up to 3 degrees or 5 percent. If the accuracy of the system is affected by out-of-level conditions normal to the use of the device, the system shall be equipped with an out-of-level sensor that inhibits the weighing operation when the system is out-of-level to the extent that the accuracy limits are exceeded.
(Added 1992)

S.2.5. Damping Means. - An automatic-indicating scale and a balance indicator shall be equipped with effective means to damp oscillations and to bring the indicating elements quickly to rest.

S.2.5.1. Digital Indicating Elements. - Digital indicating elements equipped with recording elements shall be equipped with effective means to permit the recording of weight values only when the indication is stable within:

- (a) plus or minus 3 scale divisions for scales of more than 2000 kg (5000 lb) capacity in service prior to January 1, 1981, hopper (other than grain hopper) scales with a capacity exceeding 22 000 kg (50 000 lb), and for all vehicle, axle load, livestock, and railway track scales;
- (b) plus or minus 1 scale division for all other scales.

The values recorded shall be within applicable tolerances.

S.2.5.2. Jewelers', Prescription, and Class I and Class II Scales. - A jewelers', prescription, Class I, or Class II scale shall be equipped with appropriate means for arresting the oscillation of the mechanism.

S.2.5.3. Class I and Class II Prescription Scales with a Counting Feature. – A Class I or Class II prescription scale shall indicate to the operator when the piece weight computation is complete by a stable display of the quantity placed on the load receiving element.
(Added 2003)

2.20. Scales

S.3. Design of Load-Receiving Elements.

S.3.1. Travel of Pans of Equal-Arm Scale. - The travel between limiting stops of the pans of a nonautomatic-indicating equal-arm scale not equipped with a balance indicator shall be not less than the minimum travel shown in Tables 2M and 2.

Table 2M. Minimum Travel of Pans of Nonautomatic Indicating Equal-Arm Scale Without Balance Indicator	
Nominal capacity (kilograms)	Minimum travel of pans (millimeters)
2 or less	9
2+ to 5, inclusive	13
5+ to 12, inclusive	19
Over 12	25

Table 2. Minimum Travel of Pans of Nonautomatic Indicating Equal-Arm Scale Without Balance Indicator	
Nominal capacity (pounds)	Minimum travel of pans (inch)
4 or less	0.35
4+ to 12, inclusive	0.5
12+ to 26, inclusive	0.75
Over 26	1.0

S.3.2. Drainage. - A load-receiving element intended to receive wet commodities shall be so constructed as to drain effectively.

S.3.3. Scoop Counterbalance. - A scoop on a scale used for direct sales to retail customers shall not be counterbalanced by a removable weight. A permanently attached scoop-counterbalance shall indicate clearly on both the operator's and customer's sides of the scale whether it is positioned for the scoop to be on or off the scale.

S.4. Design of Weighing Elements.

S.4.1. Antifriction Means. - Frictional effects shall be reduced to a minimum by suitable antifriction elements. Opposing surfaces and points shall be properly shaped, finished, and hardened. A platform scale having a frame around the platform shall be equipped with means to prevent interference between platform and frame.

S.4.2. Adjustable Components. - An adjustable component such as a nose-iron or potentiometer shall be held securely in adjustment. The position of a nose-iron on a scale of more than 1 000 kg (2 000 lb) capacity, as determined by the factory adjustment, shall be accurately, clearly, and permanently defined.
(Amended 1986)

S.4.3. Multiple Load-Receiving Elements. - Except for mechanical bench and counter scales, a scale with a single indicating or recording element, or a combination indicating-recording element, that is coupled to two or more load-receiving elements with independent weighing systems, shall be provided with means to prohibit the activation of any load-receiving element (or elements) not in use, and shall be provided with automatic means to indicate clearly and definitely which load-receiving element (or elements) is in use.

S.5. Design of Weighing Devices, Accuracy Class.

S.5.1. Designation of Accuracy Class. - *Weighing devices are divided into accuracy classes and shall be designated as I, II, III, III L, or IIII.*
[Nonretroactive as of January 1, 1986.]

S.5.2. Parameters for Accuracy Class. - *The accuracy class of a weighing device is designated by the manufacturer and shall comply with parameters shown in Table 3.*
[Nonretroactive as of January 1, 1986.]

S.5.3. Multi-Interval and Multi-Range Scales, Division Value. - On a multi-interval scale and multiple range scale, the value of "e" shall be equal to the value of "d."²
(Added 1986) (Amended 1995)

S.5.4. Relationship of Load Cell Verification Interval Value to the Scale Division. - *The relationship of the value for the load cell verification scale interval, v_{min} , to the scale division, d, for a specific scale installation shall be:*

² See Footnote 1 to Table 3, Parameters for Accuracy Classes.

(a) $v_{min} \leq \frac{d}{\sqrt{N}}$ where N is the number of load cells in

the scale for scales without lever systems; and

(b) $v_{min} \leq \frac{d}{\sqrt{N} \times (\text{scale multiple})}$ for scales with lever

systems.

[Nonretroactive as of January 1, 1994.]

[Note: When the value of the scale division, d , is different than the verification scale division, e , for the scale, the value of e must be used in the formulae above.]

This requirement does not apply to complete scales and weighing elements which satisfy the following criteria:

- (1) The device has been evaluated for compliance with T.N.8.1. Temperature under the National Type Evaluation Program (NTEP);
- (2) The device has received an NTEP Certificate of Conformance; and
- (3) The device must be equipped with an automatic zero-setting mechanism which cannot be made inoperative in the normal weighing mode. (A test mode which permits the disabling of the automatic zero-setting mechanism is permissible, provided the scale cannot function normally while in this mode.)

(Added 1993) (Amended 1996)

S.6. Marking Requirements. [See also G-S.1., G-S.4., G-S.6., G-S.7., G-UR.2.1.1., and UR.3.4.1.]

S.6.1. Nominal Capacity; Vehicle and Axle-Load Scales. - For all vehicle and axle-load scales, the marked nominal capacity shall not exceed the concentrated load capacity (CLC) times the quantity of the number of sections in the scale minus 0.5.

As a formula, this is stated as

$$\text{nominal capacity} \leq \text{CLC} \times (N - 0.5)$$

where N = the number of sections in the scale.

(See N.1.3.4. and T.N.3.1.)

[Nonretroactive as of January 1, 1989.]

[Note: When the device is used in a combination railway track and vehicle weighing application, the above formula shall apply only to the vehicle scale application.]

(Added 1988) (Amended 1999 and 2002)

S.6.2. Location of Marking Information. - Scales that are not permanently attached to an indicating element, and for which the load-receiving element is the only part of the weighing/load-receiving element visible after installation, may have the marking information required in G-S.1. of the General Code and S.6. of the Scales Code located in an area that is accessible only through the use of a tool; provided that the information is easily accessible (e.g., the information may appear on the junction box under an access plate). The identification information for these scales shall be located on the weighbridge (load-receiving element) near the point where the signal leaves the weighing element or beneath the nearest access cover.

(Added 1989)

S.6.3. Scales, Main Elements, and Components of Scales or Weighing Systems. - Scales, main elements of scales when not contained in a single enclosure for the entire scale, load cells for which Certificates of Conformance (CC) have been issued under the National Type Evaluation Program, and other equipment necessary to a weighing system, but having no metrological effect on the weighing system, shall be marked as specified in Table S.6.3.a. and explained in the accompanying notes (Table S.6.3.b.).

(Added 1990)

S.6.4. Railway Track Scales. - A railway track scale shall be marked with the maximum capacity of each section of the load-receiving element of the scale. Such marking shall be accurately and conspicuously presented on, or adjacent to, the identification or nomenclature plate that is attached to the indicating element of the scale. *The nominal capacity of a scale with more than two sections shall not exceed twice its rated section capacity. The nominal capacity of a two-section scale shall not exceed its rated section capacity.*

[Nonretroactive as of January 1, 2002]

(Amended 1988 and 2001)

S.6.5. Livestock Scales. - A livestock scale manufactured prior to January 1, 1989 or after January 1, 2003 shall be marked with the maximum capacity of each section of the load-receiving element of the scale. Livestock scales manufactured between January 1, 1989 and January 1, 2003 shall be marked with either the Concentrated Load Capacity (CLC) or the Section Capacity. Such marking shall be accurately and conspicuously presented on, or adjacent to the identification or nomenclature plate that is attached to the indicating element of the scale. *The nominal capacity of a scale with more than two sections shall not exceed twice its rated section capacity. The nominal capacity of a two-section scale shall not exceed its rated section capacity*.*

[*Nonretroactive as of January 1, 2003]

See also Note 14 in Table S.6.3.b.
(Added 2002) (Amended 2003)

2.20. Scales

S.6.6. Counting Feature, Minimum Individual Piece Weight and Minimum Sample Piece Count. – A Class I or Class II prescription scale with an operational counting feature shall be marked with the minimum individual piece weight and minimum number of pieces used in the sample to establish an individual piece weight.
(Added 2003)

N. Notes

N.1. Test Procedures.

N.1.1. Increasing-Load Test. - The increasing-load test shall be conducted on all scales with the test loads approximately centered on the load-receiving element of the scale, except on a scale having a nominal capacity greater than the total available known test load. When the total test load is less than the nominal capacity, the test load is used to greatest advantage by concentrating it, within prescribed load limits, over the main load supports of the scale.

N.1.2. Decreasing-Load Test (Automatic Indicating Scales). - The decreasing-load test shall be conducted with the test load approximately centered on the load-receiving element of the scale.

*Table 3
Parameters for Accuracy Classes*

Class	Value of the verification scale division (<i>d</i> or <i>e</i> ¹)	Number of scale ⁴ divisions (<i>n</i>)	
		Minimum	Maximum
SI Units			
I	equal to or greater than 1 mg	50 000	-----
II	1 to 50 mg, inclusive	100	100 000
	equal to or greater than 100 mg	5000	100 000
III ²	0.1 to 2 g, inclusive	100	10 000
	equal to or greater than 5 g	500	10 000
III L ³	equal to or greater than 2 kg	2000	10 000
III	equal to or greater than 5 g	100	1 200
INCH-POUND Units			
III	0.0002 lb to 0.005 lb, inclusive	100	10 000
	0.005 oz to 0.125 oz, inclusive	100	10 000
	equal to or greater than 0.01 lb	500	10 000
	equal to or greater than 0.25 oz	500	10 000
III L ³	equal to or greater than 5 lb	2 000	10 000
III	greater than 0.01 lb	100	1 200
	greater than 0.25 oz	100	1 200

¹ For Class I and II devices equipped with auxiliary reading means (i.e., a rider, a vernier, or a least significant decimal differentiated by size, shape, or color), the value of the verification scale division “ e ” is the value of the scale division immediately preceding the auxiliary means.

² A scale marked “For prescription weighing only” may have a verification scale division (e) not less than 0.01 g. (Added 1986) (Amended 2003)

³ The value of a scale division for crane and hopper (other than grain hopper) scales shall be not less than 0.2 kg (0.5 lb). The minimum number of scale divisions shall be not less than 1000.

⁴ On a multiple range or multi-interval scale the number of divisions for each range independently shall not exceed the maximum specified for the accuracy class. The number of scale divisions, n , for each weighing range is determined by dividing the scale capacity for each range by the verification scale division, e , for each range. On a scale system with multiple load receiving elements and multiple indications, each element considered shall not independently exceed the maximum specified for the accuracy class. If the system has a summing indicator, the n_{max} for the summed indication shall not exceed the maximum specified for the accuracy class.

[Nonretroactive as of January 1, 1986.]

(Amended 1986, 1987, 1997, 1998, 1999 and 2000) (Footnote 4 Added 1997) (Footnote 1 Amended 1999)

2.20. Scales

**Table S.6.3.a.
Marking Requirements**

To Be Marked With	Weighing Equipment				
	Weighing, load-receiving, and indicating element in same housing or covered on the same CC ¹	Indicating element not permanently attached to weighing and load-receiving element or covered by a separate CC	Weighing and load-receiving element not permanently attached to indicating element or covered by a separate CC	Load cell with CC (11)	Other equipment or device (10)
Manufacturer's ID (1)	x	x	x	x	x
Model Designation and Prefix (1)	x	x	x	x	x
Serial Number and Prefix (2)	x	x	x	x	x (16)
Certificate of Conformance Number (CC) (23)	x	x	x	x	x (23)
Accuracy Class (17)	x	x (8)	x (19)	x	
Nominal Capacity (3)(18)(20)	x	x	x		
Value of Scale Division, “d” (3)	x	x			
Value of “e” (4)	x	x			
Temperature Limits (5)	x	x	x	x	
Concentrated Load Capacity (CLC) (12)(20)(22)		x	x (9)		
Special Application (13)	x	x	x		
Maximum Number of Scale Divisions (n_{max}) (6)		x (8)	x (19)	x	
Minimum Verification Scale Division (e_{min})			x (19)		
“S” or “M” (7)				x	
Direction of Loading (15)				x	
Minimum Dead Load				x	
Maximum Capacity				x	
Safe Load Limit				x	
Load Cell Verification Interval (v_{min}) (21)				x	
Section Capacity (14)(20)(22)		x	x		

Note: For applicable notes, see Table S.6.3.b.

(Added 1990) (Amended 1992, 1999, 2000, 2001 and 2002) (Added Footnote 1, 2001)

¹ Weighing/load receiving elements and indicators which are in the same housing or which are permanently attached will generally appear on the same CC. If not in the same housing, elements shall be hard wired together or sealed with a physical seal or an electronic link. This requirement does not apply to peripheral equipment that has no input or effect on device calibrations or configurations.

Table S.6.3.b.

Notes For Table S.6.3.a.

1. Manufacturer's identification and model designation and model designation prefix*.
*[Nonretroactive as of January 1, 2003.]
(See G-S.1.) [Prefix lettering may be initial capitals, all capitals or all lower case.]
(Amended 2000)
2. Serial number [Nonretroactive as of January 1, 1968] and prefix [Nonretroactive as of January 1, 1986].
(See G-S.1.)
3. The nominal capacity and value of the scale division shall be shown together (e.g., 50 000 x 5 kg, 100 000 x 10 lb, 15 x 0.005 kg, or 30 x 0.01 lb) adjacent to the weight display when the nominal capacity and value of the scale division are not immediately apparent. Each scale division value or weight unit shall be marked on multiple range or multi-interval scales.
[Nonretroactive as of January 1, 1983.]
4. Required only if different from "d."
[Nonretroactive as of January 1, 1986.]
5. Required only on Class III, III L, and IIII devices if the temperature range on the NTEP CC is narrower than and within -10 °C to 40 °C (14 °F to 104 °F).
[Nonretroactive as of January 1, 1986.]
6. This value may be stated on load cells in units of 1 000; e.g., n: 10 is 10 000 divisions.
[Nonretroactive as of January 1, 1988.]
7. Denotes compliance for single or multiple load cell applications. It is acceptable to use a load cell with the "S" or Single Cell designation in multiple load cell applications as long as all other parameters meet applicable requirements. A load cell with the "M" or Multiple Cell designation can be used only in multiple load cell applications.
[Nonretroactive as of January 1, 1988.]
(Amended 1999)
8. An indicating element not permanently attached to a weighing element shall be clearly and permanently marked with the accuracy Class of I, II, III, III L, or IIII, as appropriate, and the maximum number of scale divisions, n_{max} , for which the indicator complies with the applicable requirement. Indicating elements that qualify for use in both Class III and III L applications may be marked III/III L and shall be marked with the maximum number of scale divisions for which the device complies with the applicable requirements for each accuracy class.
[Nonretroactive as of January 1, 1988.]
9. For vehicle and axle-load scales only. The CLC shall be added to the load-receiving element of any such scale not previously marked at the time of modification.
[Nonretroactive as of January 1, 1989.]
(Amended 2002)
10. Necessary to the weighing system but having no metrological effect, e.g., auxiliary remote display, keyboard, etc.
11. The markings may be either on the load cell or in an accompanying document; except that, if an accompanying document is provided, the serial number shall appear both on the load cell and in the document.
[Nonretroactive as of January 1, 1988.] The manufacturer's name or trademark, the model designation, and identifying symbol for the serial number shall also be marked both on the load cell and in any accompanying document.
[Nonretroactive as of January 1, 1991.]
12. Required on the indicating element and the load-receiving element of vehicle and axle-load scales. Such marking shall be identified as "concentrated load capacity" or by the abbreviation "CLC".*
[*Nonretroactive as of January 1, 1989.]
(Amended 2002)
13. A scale designed for a special application rather than general use shall be conspicuously marked with suitable words, visible to the operator and to the customer, restricting its use to that application, e.g., postal scale, prepack scale, weight classifier, etc.* When a scale is installed with an operational counting feature, the scale shall be marked on both the operator and customer sides with the statement "The counting feature is not legal for trade," except when a Class I or Class II prescription scale complies with all Handbook 44 requirements applicable to counting features.
[*Nonretroactive as of January 1, 1986.]
(Amended 1994 and 2003)
14. Required on livestock* and railway track scales. When marked on vehicle and axle-load scales manufactured before January 1, 1989, it may be used as the CLC. For livestock scales manufactured between January 1, 1989 and January 1, 2003, required markings may be either CLC or section capacity.
[*Nonretroactive as of January 1, 2003.]
(Amended 2002 and 2003)

Table S.6.3.b.

Notes For Table S.6.3.a. (Continued)

- | | |
|--|--|
| <p>15. <i>Required if the direction of loading the load cell is not obvious.</i>
[Nonretroactive as of January 1, 1988.]</p> <p>16. <i>Serial number [Nonretroactive as of January 1, 1968] and prefix [Nonretroactive as of January 1, 1986]. (See G-S.1.) Modules without “intelligence” on a modular system (e.g., printer, keyboard module, cash drawer, and secondary display in a point-of-sale system) are not required to have serial numbers.</i></p> <p>17. <i>The accuracy Class of a device shall be marked on the device with the appropriate designation as I, II, III, III L, or IIII.</i>
[Nonretroactive as of January 1, 1986.]</p> <p>18. The nominal capacity shall be conspicuously marked as follows:</p> <ul style="list-style-type: none"> (a) on any scale equipped with unit weights or weight ranges; (b) on any scale with which counterpoise or equal-arm weights are intended to be used; (c) on any automatic-indicating or recording scale so constructed that the capacity of the indicating or recording element, or elements, is not immediately apparent; (d) on any scale with a nominal capacity less than the sum of the reading elements; and (e) <i>on the load-receiving element (weighbridge) of vehicle, axle-load, and livestock scales.*</i>
[*Nonretroactive as of January 1, 1989.] | <p>19. <i>Nonretroactive as of January 1, 1988.</i>
(Amended 1992)</p> <p>20. <i>Combination vehicle/railway track scales must be marked with both the nominal capacity and CLC for vehicle weighing and the nominal capacity and section capacity for railway weighing. All other requirements relating to these markings will apply.</i>
[Nonretroactive as of January 1, 2000]
(Added 1999)</p> <p>21. The value of the load cell verification interval (v_{min}) must be stated in mass units. In addition to this information, a device may be marked with supplemental representations of v_{min}.
[Nonretroactive as of January 1, 2001]
(Added 1999)</p> <p>22. <i>Combination vehicle/livestock scales must be marked with both the CLC for vehicle weighing and the section capacity for livestock weighing. All other requirements relative to these markings will apply.</i>
[Nonretroactive as of January 1, 2003]
(Added 2002)</p> <p><i>Note: The marked section capacity for livestock weighing may be less than the marked CLC for vehicle weighing.</i>
(Added 2003)</p> <p>23. <i>Required only if a CC has been issued for the device or equipment.</i>
[Nonretroactive as of January 1, 2003]
(G-S.1. Identification (f) Added 2001)</p> |
|--|--|

N.1.2.1. Scales Marked I, II, III, or IIII. - Except for portable wheel load weighers, decreasing-load tests shall be conducted on scales marked I, II, III, or IIII and with n equal to or greater than 1000 with test loads equal to the maximum test load at each tolerance value. For example, on a Class III scale, at test loads equal to 4000d, 2000d, and 500d; for scales with n less than 1000, the test load shall be equal to one-half of the maximum load applied in the increasing-load test. (See Table 6.)
(Amended 1998)

N.1.2.2. All Other Scales. - On all other scales, except for portable wheel load weighers, the decreasing-load test shall be conducted with a test load equal to one-half of the maximum load applied in the increasing-load test.
(Amended 1998)

N.1.3. Shift Test.

N.1.3.1. Bench or Counter Scales. - A shift test shall be conducted with a half-capacity test load centered successively at four points equidistant between the center and the front, left, back, and right edges of the load-receiving element.

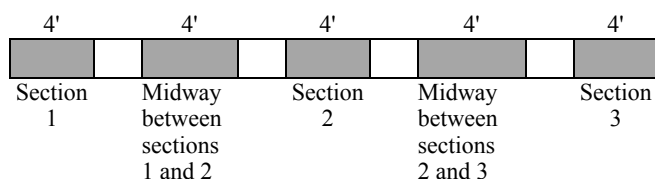
N.1.3.2. Dairy-Product-Test Scales. - A shift test shall be conducted with a test load of 18 grams successively positioned at all points on which a weight might reasonably be placed in the course of normal use of the scale.

N.1.3.3. Equal-Arm Scales. - A shift test shall be conducted with a half-capacity test load positioned on each pan as prescribed in N.1.3.1. An equal test load shall be centered on the other pan.

N.1.3.4. Vehicle Scales, Axle-Load Scales, and Livestock Scales.

N.1.3.4.1. Vehicle Scales, Axle-Load Scales, and Combination Vehicle/Livestock Scales.

- (a) **Minimum Shift Test.** At least one shift test shall be conducted with a minimum test load of 12.5% of scale capacity, which may be performed anywhere on the load-receiving element using the prescribed test patterns and maximum test loads specified below. (Combination Vehicle/Livestock Scales shall also be tested consistent with N.1.3.4.2.) (Amended 1991, 2000 and 2003)
- (b) **Prescribed Test Pattern and Loading for Vehicle Scales, Axle-Load Scales, and Combination Vehicle/Livestock Scales.** The normal prescribed test pattern shall be an area of 1.2 m (4 ft) in length and 3.0 m (10 ft) in width or the width of the scale platform, whichever is less. Multiple test patterns may be utilized when loaded in accordance with paragraph (c) (d), or (e) as applicable. An example of a possible test pattern is shown in the diagram below. (Amended 1997, 2001 and 2003)



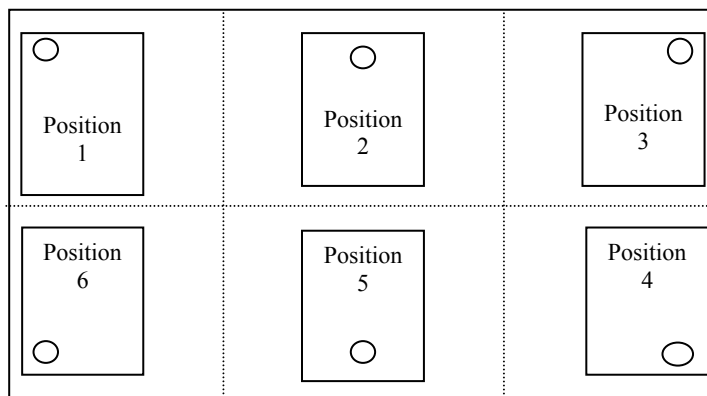
- (c) **Loading Precautions for Vehicle Scales, Axle-Load Scales, and Combination Vehicle/Livestock Scales.** When loading the scale for testing, one side of the test pattern shall be loaded to no more than half of the concentrated load capacity or test load before loading the other side. The area covered by the test load may be less than 1.2 m (4 ft) x 3.0 m (10 ft) or the width of the scale platform; whichever is less; for test patterns less than 1.2 m (4 ft) in length the maximum loading shall meet the formula: [(wheel base of test cart or length of test load divided by 48 in) x 0.9 x CLC]. The maximum test load applied to each test pattern shall not exceed the concentrated load capacity of the scale. When the test pattern exceeds 1.2 m (4 ft), the maximum test load applied shall not exceed the concentrated load capacity times the largest “r” factor in Table UR.3.2.1. for the length of the area covered by the test

load. For load-receiving elements installed prior to January 1, 1989, the rated section capacity may be substituted for concentrated load capacity to determine maximum loading. An example of a possible test pattern is shown above.

(Amended 1997 and 2003)

- (d) **Multiple Pattern Loading.** To test the nominal capacity, multiple patterns may be simultaneously loaded in a manner consistent with the method of use. (Amended 2003)
- (e) **Other Designs.** Special design scales and those that are wider than 3.7 m (12 ft) shall be tested in a manner consistent with the method of use but following the principles described above. (Amended 1988 and 2003)

N.1.3.4.2. Prescribed Test Pattern and Test Loads for Livestock Scales with More Than Two Sections and Combination Vehicle/Livestock Scales. – A minimum test load of 5000 kg (10 000 lb) or one-half of the rated section capacity, whichever is less, shall be placed, as nearly as possible, successively over each main load support as shown in the diagram below. For livestock scales manufactured between January 1, 1989, and January 1, 2003, the required loading shall be no greater than one-half CLC. (Two-section livestock scales shall be tested consistent with N.1.3.8.)



○ = Load Bearing Point

(Added 2003)

N.1.3.5. Railway Track Scales Weighing Individual Cars in Single Drafts. - A shift test shall be conducted with at least two different test loads, if available, distributed over, to the right and left of, each pair of main levers or other weighing elements supporting each section of the scale.

2.20. Scales

N.1.3.6. Monorail Scales, Static Test. - A shift test shall be conducted with a test load equal to the largest load that can be anticipated to be weighed in a given installation, but never less than one-half scale capacity. The load shall be placed successively on the right end, the left end, and the center of the live rail.
(Added 1985)

N.1.3.6.1. Dynamic Monorail Weighing

System: Dynamic tests with livestock carcasses should be conducted to duplicate actual use conditions. No less than 20 test loads using carcasses or portions of carcasses of the type normally weighed should be used in the dynamic test; two additional test loads may be included in the test run for use in the event that one or two tests loads are rendered unusable during the dynamic test. Prior to starting the dynamic test, the test carcasses must be positioned far enough ahead of the scale so that their swaying motion settles to duplicate the normal sway of a continuously running plant chain. If the plant conveyor chain does not space or prevent the carcasses from touching one another, dynamic tests should not be conducted until this condition has been corrected.

All carcasses shall be individually weighed statically on either the same scale being tested dynamically or another monorail scale with the same or smaller divisions and in close proximity. (The scale selected for weighing the carcasses shall first be tested statically with test weights.) If the scale being tested is used for weighing freshly slaughtered animals, (often referred to as a "hot scale"), care must be taken to get a static weighment as quickly as possible before or following the dynamic weighment to avoid loss due to shrink. If multiple dynamic tests are conducted using the same carcasses, static weights should be obtained before and after the multiple dynamic tests. If the carcass changes weight between static tests, the amount of the weight change should be taken into account, or the carcass should be disregarded for tolerance purposes.

(Note: For a dynamic monorail test, the reference scale shall comply with the principles in the Fundamental Consideration Paragraph 3.2. Tolerances for Standards.)
(Added 1996) (Amended 1999)

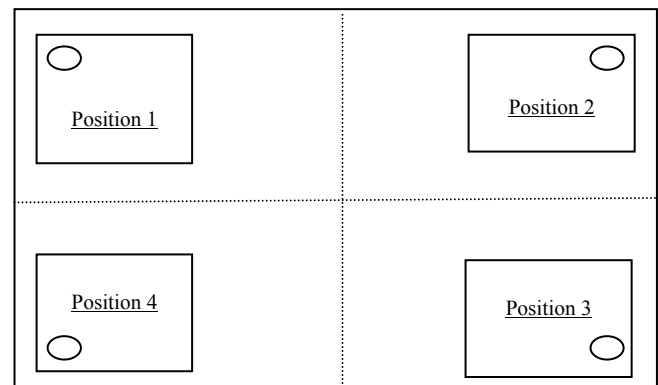
N.1.3.7. Vehicle On-Board Weighing Systems. -

The shift test for a vehicle on-board weighing system shall be conducted in a manner consistent with its normal use. For systems that weigh as part of the lifting cycle, the center of gravity of the load may be shifted in the vertical direction as well as from side to side. In other cases, the center of gravity may be moved to the extremes of the load-receiving element using loads of a magnitude that reflect normal use (i.e., the load for the shift test may exceed one-half scale capacity), and may, in some cases, be equal to the capacity of the scale. The shift test may be conducted when the weighing system is out-of-level to the extent that the weighing system remains operational.
(Added 1992)

N.1.3.8. All Other Scales Except Crane Scales, Hanging Scales, Hopper Scales, Wheel-Load Weighers, and Portable Axle-Load Weighers. -

A shift test shall be conducted using the following prescribed test loads and test patterns. For livestock scales, the shift test load shall not exceed one-half the rated section capacity or one-half the rated concentrated load capacity, whichever is applicable. A shift test shall be conducted using either:
(Amended 1987 and 2003)

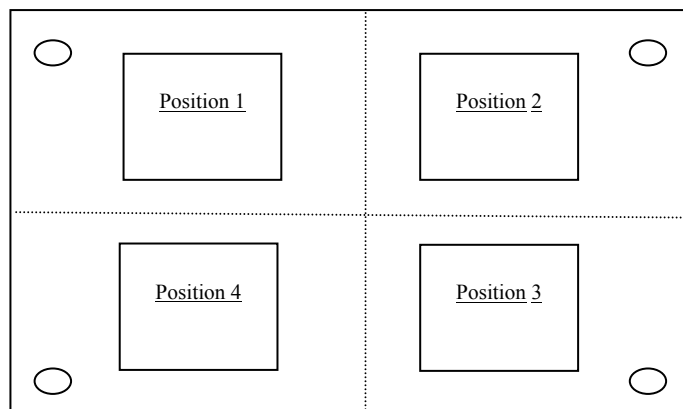
- (a) A one-quarter nominal capacity test load centered as nearly as possible, successively over each main load support as shown in the diagram below; or



○ = Load Bearing

(Added 2003)

- (b) A one-half nominal capacity test load centered as nearly as possible, successively at the center of each quarter of the load-receiving element as shown in the diagram below.



○ = Load Bearing Point

(Added 2003)

N.1.4. Sensitivity Test. - A sensitivity test shall be conducted on nonautomatic-indicating (weighbeam) scales only, with the weighing device in equilibrium at zero-load and at maximum test load. The test shall be conducted by increasing or decreasing the test load in an amount equal to the applicable value specified in T.2. or T.N.6.

N.1.5. Discrimination Test. - *A discrimination test shall be conducted on all automatic indicating scales with the weighing device in equilibrium at zero load and at maximum test load, and under controlled conditions in which environmental factors are reduced to the extent that they will not affect the results obtained.*

[Nonretroactive as of January 1, 1986.]

(Added 1985)

N.1.5.1. Digital Device. - On a digital device, this test is conducted from just below the lower edge of the zone of uncertainty for increasing load tests, or from just above the upper edge of the zone of uncertainty for decreasing-load tests.

N.1.6. RFI Susceptibility Tests, Field Evaluation. - An RFI test shall be conducted at a given installation when the presence of RFI has been verified and characterized if those conditions are considered "usual and customary."
(Added 1986)

N.1.7. Ratio Test. - A ratio test shall be conducted on all scales employing counterpoise weights and on nonautomatic-indicating equal-arm scales.

N.1.8. Material Tests. - A material test shall be conducted on all customer-operated bulk weighing systems for recycled materials using bulk material for which the device is used. Insert into the device, in a normal manner, several accurately preweighed samples (free of foreign material) in varying amounts approximating average drafts.

N.1.9. Zero-Load Balance Change. - A zero-load balance change test shall be conducted on all scales after the removal of any test load. The zero-load balance should not change by more than the minimum tolerance applicable. (Also see G-UR.4.2.) (Renumbered 1988)

N.1.10. Counting Feature Test. - A test of the counting function shall be conducted on all Class I and Class II prescription scales having an active counting feature used in "legal for trade" applications. The test should verify that the scale will not accept a sample with less than either the minimum sample piece count or the minimum sample weight of 30 e. Counting feature accuracy should be verified at a minimum of two test loads. Verification of the count calculations shall be based upon the weight indication of the test load.

Note:

- (1) The minimum sample weight is equal to the marked minimum individual piece weight times the marked minimum sample piece count.
- (2) Test load as used in this section refers to actual calibration test weights selected from an appropriate test weight class.

(Added 2003)

N.1.11. Substitution Test. - In the substitution test procedure, material or objects are substituted for known test weights, or a combination of known test weights and previously quantified material or objects, using the scale under test as a comparator. Additional test weights or other known test loads may be added to the known test load to evaluate higher weight ranges on the scale.

(Added 2003)

N.1.12. Strain-Load Test. - In the strain load test procedure, an unknown quantity of material or objects are used to establish a reference load or tare to which test weights or substitution test loads are added.

(Added 2003)

N.2. Verification (Testing) Standards. - Field standard weights used in verifying weighing devices shall comply with requirements of NIST Handbook 105-1 (Class F) or the tolerances expressed in Fundamental Considerations, paragraph 3.2. (i.e., one-third of the smallest tolerance applied).
(Amended 1986)

TABLE 4. RECOMMENDED² MINIMUM TEST WEIGHTS AND TEST LOADS¹

Device Capacity (Pounds)	Recommended ² minimums (in terms of device capacity)		Recommended ² (where practicable)
	Test Weights (greater of)	Test Loads	
0 to 100	105%		
101 to 1,000	50% or 100 lb	105%	
1,001 to 40,000	25% or 500 lb	50%	Test weights to dial face capacity, 1,000d or test load to used capacity, if greater than minimums specified
40,000 +	12.5% or 10,000 lb	25%	

¹ The term “test load” means the sum of the combination of field standard test weights and any other applied load used in the conduct of a test using substitution or build-up test methods.

Except for railway track scales, the recommended² minimum test of a Class III L scale shall consist of one test from zero to at least 25% of the scale capacity and then one strain load test to at least the used capacity of the device.

Each test is to be conducted using a known test load of at least 25% of scale capacity. This test load may be comprised entirely of test weights or a combination of test weights equal to at least 12.5% of scale capacity and a substitution load.

² The word “Recommended” will be deleted from this section as of January 1, 1998. This will make the amounts of test weights and test loads specified in Table 4 mandatory as of January 1, 1998.

N.3. Minimum Test Weights and Test Loads*.

[NOT ADOPTED]

4002.2. Scales (2.20.)

(a) **Recommended Minimum² Test Weights and Test Loads.¹** The recommended² minimum test weights and test loads for in-service tests (except railway track scales) are shown in Table 4. [See Table 4 for ¹ and ²]

N.3.1. Minimum Test-Weight Load and Recommended Strain-Load Test for Railway Track Scales. (Amended 1990)

N.3.1.1. Approval. - The test-weight load shall be not less than 35 000 kg (80 000 lb). A strain-load test conducted up to the used capacity of the weighing system is recommended.
(Added 1990)

N.3.1.2. Interim Approval. - A test-weight load of not less than 13 500 kg (30 000 lb) and a strain-load test up to at least 25 percent of scale capacity may be used to return a scale into service following repairs.
(Added 1990)

Note: The length of time the scale may be used following an interim test is at the discretion of the official with statutory authority.
(Added 1990)

N.3.1.3. Enforcement Action for Inaccuracy. - To take enforcement action on a scale that is found to be inaccurate, a minimum test load of 13 500 kg (30 000 lb) must be used.
(Added 1990)

2.20. Scales

N.4. Coupled-in-Motion Railroad Weighing Systems.³

N.4.1. Weighing Systems Used to Weigh Trains of Less Than 10 Cars. - These weighing systems shall be tested using a consecutive-car test train consisting of the number of cars weighed in the normal operation run over the weighing system a minimum of five times in each mode of operation following the final calibration.
(Added 1990; Amended 1992)

N.4.2. Weighing Systems Placed in Service Prior to January 1, 1991, and Used to Weigh Trains of 10 or More Cars. - The minimum test train shall be a consecutive-car test train of no less than 10 cars run over the scale a minimum of five times in each mode of operation following final calibration.
(Added 1990; Amended 1992)

³ A test weight car that is representative of one of the types of cars typically weighed on the scale under test may be used wherever reference weight cars are specified.
(Added 1991)

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N.4.3. Weighing Systems Placed in Service on or After January 1, 1991, and Used to Weigh Trains of 10 or More Cars.

- (a) These weighing systems shall be tested using a consecutive-car test train of no less than 10 cars run over the scale a minimum of five times in each mode of operation following final calibration; or
 - (b) if the official with statutory authority determines it necessary, the As Used Test Procedures outlined in N.4.3.1. shall be used.
- (Added 1990; Amended 1992)

N.4.3.1. As Used Test Procedures - A weighing system shall be tested in a manner that represents the normal method of operation and length(s) of trains normally weighed. The weighing systems may be tested using either:

- (1) a consecutive-car test train of a length typical of train(s) normally weighed; or
- (2) a distributed-car test train of a length typical of train(s) normally weighed.

However, a consecutive-car test train of a shorter length may be used provided that initial verification test results for the shorter consecutive-car test train agree with the test results for the distributed-car or full-length consecutive-car test train as specified in N.4.3.1.1.

The official with statutory authority shall be responsible for determining the minimum test train length to be used on subsequent tests.

(Added 1990; Amended 1992)

N.4.3.1.1. Initial Verification. - Initial verification tests should be performed on any new weighing system and whenever either the track structure or the operating procedure changes. If a consecutive-car test train of length shorter than trains normally weighed is to be used for subsequent verification, the shorter consecutive-car test train results shall be compared either to a distributed-car or to a consecutive-car test train of length(s) typical of train(s) normally weighed.

The difference between the total train weight of the train(s) representing the normal method of operation and the weight of the shorter consecutive-car test train shall not exceed 0.15 percent. If the difference in test results exceeds 0.15 percent, the length of the shorter consecutive-car test train shall be increased until agreement within 0.15 percent is achieved.

Any adjustments to the weighing system based upon the use of a shorter consecutive-car test train shall be offset to correct the bias that was observed between the full-length train test and the shorter consecutive-car test train.

(Added 1990; Amended 1992, 1993)

N.4.3.1.2. Subsequent Verification. - The test train may consist of either a consecutive-car test train with a length not less than that used in initial verification, or a distributed-car test train representing the number of cars used in the normal operation.

(Added 1990)

N.4.3.1.3. Distributed-Car Test Trains.

- (a) The length of the train shall be typical of trains that are normally weighed.
 - (b) The reference weight cars shall be split into three groups, each group consisting of 10 cars or 10 percent of the train length, whichever is less.
- (Amended 1991)
- (c) The test groups shall be placed near the front, around the middle, and near the end of the train.
 - (d) Following the final adjustment, the distributed-car test train shall be run over the scale at least three times or shall produce 50 weight values, whichever is greater.
 - (e) The weighing system shall be tested in each mode of operation.
- (Added 1990; Amended 1992)

N.4.3.1.4. Consecutive-Car Test Trains.

- (a) A consecutive-car test train shall consist of at least 10 cars.
- (b) If the consecutive-car test train consists of between 10 and 20 cars, inclusive, it shall be run over the scale a minimum of five times in each mode of operation following the final calibration.
- (c) If the consecutive-car test train consists of more than 20 cars, it shall be run over the scale a minimum of three times in each mode of operation.

(Added 1990; Amended 1992)

2.20. Scales

N.5. Uncoupled-in-Motion Railroad Weighing System. - An uncoupled-in-motion scale shall be tested statically before being tested in motion by passing railroad reference weight cars over the scale. When an uncoupled-in-motion railroad weighing system is tested, the car speed and the direction of travel shall be the same as when the scale is in normal use. The minimum in-motion test shall be three reference weight cars passed over the scale three times. The cars shall be selected to cover the range of weights that are normally weighed on the system and to reflect the types of cars normally weighed. (Added 1993)

N.6. Nominal Capacity of Prescription Scales. - The nominal capacity of a prescription scale shall be assumed to be 1/2 apothecary ounce, unless otherwise marked. (Applicable only to scales not marked with an accuracy class.)

T. Tolerances Applicable to Devices not Marked I, II, III, III L, or IIII

T.1. Tolerance Values.

T.1.1. General. - The tolerances applicable to devices not marked with an accuracy class shall have the tolerances applied as specified in Table T.1.1. (Amended 1990)

T.1.2. Postal and Parcel Post Scales. - The tolerances for postal and parcel post scales are given in Table T.1.1. and Table 5. (Amended 1990)

T.2. Sensitivity Requirement (SR)

T.2.1. Application. - The sensitivity requirement (SR) is applicable to all nonautomatic-indicating scales not marked I, II, III, III L, or IIII, and is the same whether acceptance or maintenance tolerances apply.

T.2.2. General. - Except for scales specified in paragraphs T.2.3. through T.2.8.: 2d, 0.2 percent of the scale capacity, or 40 lb, whichever is least.

T.2.3. Prescription Scales. - 6 mg (0.1 grain).

T.2.4. Jewelers' Scales.

T.2.4.1. With One-Half Ounce Capacity or Less. - 6 mg (0.1 grain).

T.2.4.2. With More Than One-Half Ounce Capacity. - 1d or 0.05 percent of the scale capacity, whichever is less.

T.2.5. Dairy-Product-Test Scales

T.2.5.1. Used in Determining Butterfat Content. - 32 mg (0.5 grain).

T.2.5.2. Used in Determining Moisture Content. - 19 mg (0.3 grain).

Table 5. Maintenance and Acceptance Tolerances for Unmarked Postal and Parcel Post Scales					
Scale Capacity	Test loads	Maintenance tolerance (±)		Acceptance tolerance (±)	
(lb)	(lb)	(oz)	(lb)	(oz)	(lb)
0 to 4, inclusive*	0 to 1, inclusive	1/32	0.002	1/32	0.002
	over 1	1/8	0.008	1/16	0.004
over 4*	0 to 7, inclusive	3/16	0.012	3/16	0.012
	7+ to 24, inclusive	3/8	0.024	3/16	0.012
	24+ to 30, inclusive	1/2	0.030	1/4	0.015
	over 30	0.1% of Test Load		0.05% of Test Load	
*See Table T.1.1. for scales designed and/or used to weigh loads less than 2 lb.					

Table T.1.1. Tolerances for Unmarked Scales						
Type of Device	Subcategory	Min. Tol.	Accept. Tol.	Maint. Tol.	Decreasing Load Multiplier ¹	Other Applicable Requirements
Vehicle, axle-load, livestock, railway track (weighing statically), Crane, and hopper (other than grain hopper)		Class III L, T.N.3.1 (Table 6) and T.N.3.2.			1.0	T.N.2., T.N.3., T.N.4.1., T.N.4.2., T.N.4.3., T.N.4.4., T.N.5., T.N.7.2.
Grain test scales	n ≤ 10 000 n > 10 000	Class III, T.N.3.1. (Table 6) and T.N.3.2. Class II, T.N.3.1. (Table 6) and T.N.3.2.			1.0	
Railway track scales Weighing in motion		T.N.3.6. except that for T.N.3.6.2. (a), no single error shall exceed four times the maintenance tolerance.			1.0	
Monorail Scales, In-Motion		T.N.3.8.			1.0	
Customer-Operated Bulk-Weighing Systems for Recycled Materials		± 5% of applied material test load. Average error on 10 or more test loads ≤ 2.5%.			1.0	
Wheel-load weighers and Portable axle-load Scales	Tested individually or in pairs ²	0.5d or 50 lb, whichever is greater	1% of test load	2% of test load	1.5 ³	
Prescription scales		0.1 grain (6 mg)	0.1 % of test load load	0.1% of test load	1.5	
Jewelers' scales	Graduated	0.5d	0.05% of test load	0.05% of test load	1.5	
	Ungraduated	Sensitivity or smallest weight, whichever is less				
Dairy-product-test scale	Loads < 18 g 18 g load	0.2 grain 0.2 grain	0.2 grain 0.3 grain	0.2 grain 0.5 grain	1.5	
Postal and parcel post scales Designed/used to weigh loads < 2 lb	Loads < 2 lb	15 grain, 1 g, 1/32 oz, 0.03 oz, or 0.002 lb	15 grain, 1 g, 1/32 oz, 0.03 oz, or 0.002 lb	15 grain, 1 g, 1/32 oz, 0.03 oz, or 0.002 lb	1.5	
	Loads ≥ 2 lb	Table 5	Table 5	Table 5		
Other postal and parcel post scales		Table 5	Table 5	Table 5	1.5	
All other scales	n > 5 000	0.5d or 0.05% of scale capacity, whichever is less	0.05% of test load	0.1% of test load	1.5	T.N.2.5., T.N.4.1., T.N.4.2., T.N.4.3., T.N.5., T.N.7.2.
	n ≤ 5 000	Class III, T.N.3.1., Table 6 and T.N.3.2.			1.0	T.N.2., T.N.3., T.N.4.1., T.N.4.2., T.N.4.3., T.N.5., T.N.7.2.

¹ The decreasing load test applies only to automatic indicating scales.

² If marked and tested as a pair, the tolerance shall be applied to the sum of the indications.

³ The decreasing load test does not apply to portable wheel load weighers.

(Added 1990; Amended 1992 and 1998)

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T.2.6. Grain Test Scales. - The sensitivity shall be as stated in T.N.6.
(Amended 1987)

T.2.7. Vehicle, Axle-Load, Livestock, and Animal Scales.

T.2.7.1. Equipped With Balance Indicators. - 1d.

T.2.7.2. Not Equipped With Balance Indicators. - 2d or 0.2 percent of the scale capacity, whichever is less.

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(d) Livestock Scales Not Equipped With Balance Indicator. The Sensitivity Requirement for livestock scales not equipped with a balance indicator shall be 10 pounds, notwithstanding the requirements of Handbook 44, Section 2.20. Scales, T.2.7.2.

T.2.8. Railway Track Scales. - 3d or 100 lb, whichever is less.

T.3. Sensitivity Requirement, Equilibrium Change Required. The minimum change in equilibrium with test loads equal to the values specified in T.2. shall be as follows:

- (a) Scale With a Trig Loop but Without a Balance Indicator. The position of rest of the weighbeam shall change from the center of the trig loop to the top or bottom, as the case may be.
- (b) Scale With a Single Balance Indicator and Having a Nominal Capacity of Less Than 250 g (500 lb). The position of rest of the indicator shall change 1.0 mm (0.04 in) or one division on the graduated scale, whichever is greater.
- (c) Scale With a Single Balance Indicator and Having a Nominal Capacity of 250 kg (500 lb) or Greater. The position of rest of the indicator shall change 6.4 mm (0.25 in) or one division on the graduated scale or the width of the central target area, whichever is greater. However, the indicator on a batching scale shall change 3.2 mm (0.125 in) or one division on the graduated scale, whichever is greater.
- (d) Scale With Two Opposite-Moving Balance Indicators. The position of rest of the two indicators moving in opposite directions shall change 1.0 mm (0.04 in) with respect to each other
- (e) Scale With Neither a Trig Loop Nor a Balance Indicator. The position of rest of the weighbeam or lever system shall change from the horizontal, or midway between limiting stops, to either limit of motion.

T.4. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility. - The difference between the weight indication with the disturbance and the weight indication without the disturbance, shall not exceed one scale division (d) or the equipment shall:

- (a) blank the indication, or
 - (b) provide an error message, or
 - (c) the indicator shall be so completely unstable that it could not be interpreted, or transmitted into memory or to a recording element, as a correct measurement value.
- (Added 1986)

T.5. Operating Temperature. - *An indicating or recording element shall not display or record any usable values until the operating temperature necessary for accurate weighing and a stable zero-balance condition has been attained.*
[Nonretroactive and effective January 1, 1981.]
(Added 1986)

T.N. Tolerances Applicable to Devices Marked I, II, III, III L, & IIII.

T.N.1. Principles.

T.N.1.1. Design. - The tolerance for a weighing device is a performance requirement independent of the design principle used.

T.N.1.2. Accuracy Classes. - Weighing devices are divided into accuracy classes according to the number of scale divisions (n) and the value of the scale division (d).

T.N.1.3. Scale Division. - The tolerance for a weighing device is related to the value of the scale division (d) or the value of the verification scale division (e) and is generally expressed in terms of d or e.

T.N.2. Tolerance Application.

T.N.2.1. General. - The tolerance values are positive (+) and negative (-) with the weighing device adjusted to zero at no load. When tare is in use, the tolerance values are applied from the tare zero reference; the tolerance values apply to certified test loads only.

T.N.2.2. Type Evaluation Examinations. - For type evaluation examinations, the tolerance values apply to increasing and decreasing load tests within the temperature, power supply, and barometric pressure limits specified in T.N.8.

T.N.2.3. Subsequent Verification Examinations. - For subsequent verification examinations, the tolerance values apply regardless of the influence factors in effect at the time of the conduct of the examination. (Also see G-N.2.)

T.N.2.4. Multi-Interval and Multiple Range (Variable Division-Value) Scales. - For multi-interval and multiple range scales, the tolerance values are based on the value of the scale division of the range in use.
(Amended 2000)

T.N.2.5. Ratio Tests. - For ratio tests, the tolerance values are 0.75 of the applicable tolerances.

T.N.3. Tolerance Values.

T.N.3.1. Maintenance Tolerance Values. - The maintenance tolerance values are as specified in Table 6.

T.N.3.2. Acceptance Tolerance Values. - The acceptance tolerance values shall be one-half the maintenance tolerance values.

T.N.3.3. Wheel-Load Weighers and Portable Axle-Load Weighers of Class III. - The tolerance values are two times the values specified in T.N.3.1. and T.N.3.2.
(Amended 1986)

T.N.3.4. Crane and Hopper (Other than Grain Hopper) Scales. - The maintenance and acceptance tolerances shall be as specified in T.N.3.1. and T.N.3.2. for Class III L, except that the tolerance for crane and construction materials hopper scales shall not be less than 1d or 0.1 percent of the scale capacity, whichever is less.
(Amended 1986)

T.N.3.5. Separate Main Elements: Load Transmitting Element, Indicating Element, Etc. - If a main element separate from a weighing device is submitted for type evaluation, the tolerance for the element is 0.7 that for the

complete weighing device. This fraction includes the tolerance attributable to the testing devices used.

T.N.3.6. Coupled-In-Motion Railroad Weighing Systems. - The maintenance and acceptance tolerance values for the group of weight values appropriate to the application must satisfy the following conditions:
(Amended 1990 and 1992)

T.N.3.6.1. - For any group of weight values, the difference in the sum of the individual in-motion car weights of the group as compared to the sum of the individual static weights shall not exceed 0.2 percent.
(Amended 1990)

T.N.3.6.2. - If a weighing system is used to weigh trains of five or more cars, and if the individual car weights are used, any single weight value within the group must meet the following criteria:

- (a) no single error may exceed three times the static maintenance tolerance;
- (b) not more than 5 percent of the errors may exceed two times the static maintenance tolerance; and
- (c) not more than 35 percent of the errors may exceed the static maintenance tolerance.

(Amended 1990 and 1992)

T.N.3.6.3. - For any group of weight values wherein the sole purpose is to determine the sum of the group, T.N.3.6.1. alone applies.
(Amended 1990)

T.N.3.6.4. - For a weighing system used to weigh trains of less than five cars, no single car weight within the group may exceed the static maintenance tolerance.
(Amended 1990 and 1992)

Table 6. Maintenance Tolerances (All values in this table are in scale divisions)				
Tolerance in Scale Divisions				
	1	2	3	4
Class	Test Load			
I	0 – 50 000	50 001 - 200 000	200 001 +	
II	0 – 5 000	5 001 - 20 000	20 001 +	
III	0 – 500	501 - 2 000	2 001 - 4 000	4 001 +
III L	0 – 50	51 - 200	201 - 400	401 +
III L	0 – 500	501 - 1 000	(Add 1d for each additional 500d or fraction thereof)	

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T.N.3.7. Uncoupled-in-Motion Railroad Weighing Systems. - The maintenance and acceptance tolerance values for any single weighment within a group of noninteractive (i.e., uncoupled) loads, the weighment error shall not exceed the static maintenance tolerance.
(Amended 1992)

T.N.3.8. Dynamic Monorail Weighing System. - Acceptance tolerance shall be the same as the maintenance tolerance shown in Table 6. On a dynamic test of 20 or more individual test loads, 10 percent of the individual test loads may be in error, each not to exceed two times the tolerance. The error on the total of the individual test loads shall not exceed ± 0.2 percent. (See also Note in N.1.3.6.1.) *For equipment undergoing type evaluation, a tolerance equal to one-half the maintenance tolerance values shown in Table 6 shall apply.*
[Nonretroactive January 1, 2002]
(Added 1986) (Amended 1999 and 2001)

T.N.3.9. Materials Test on Customer-Operated Bulk Weighing Systems for Recycled Materials. - The maintenance and acceptance tolerance shall be ± 5 percent of the applied materials test load except that the average error on 10 or more test materials test loads shall not exceed ± 2.5 percent.
(Added 1986)

T.N.3.10. Prescription Scales with a Counting Feature. In addition to Table 6 Maintenance Tolerances (for weight), the indicated piece count value computed by a Class I or Class II prescription scale counting feature shall comply with the tolerances in Table T.N.3.10.

Table T.N.3.10. Maintenance and Acceptance Tolerances in Excess and in Deficiency for Count	
Indication of Count	Tolerance (piece count)
0 to 100	0
101 to 200	1
201 or more	0.5%

(Added 2003)

T.N.3.11. Tolerances for Substitution Test. – Tolerances are applied to the scale based on the substitution test load.
(Added 2003)

T.N.3.12. Tolerances for Strain-Load Test. – Tolerances apply only to the test weights or substitution test loads.
(Added 2003)

T.N.4. Agreement of Indications.

T.N.4.1. Multiple Indicating/Recording Elements. - In the case of a scale or weighing system equipped with more than one indicating element or indicating element and recording element combination, where the indicators or indicator/recorder combination are intended to be used independently of one another, tolerances shall be applied independently to each indicator or indicator/recorder combination.
(Amended 1986)

T.N.4.2. Single Indicating/Recording Element. - In the case of a scale or weighing system with a single indicating element or an indicating/recording element combination and equipped with component parts such as unit weights, weighbeam and weights, or multiple weighbeams that can be used in combination to indicate a weight, the difference in the weight value indications of any load shall not be greater than the absolute value of the applicable tolerance for that load, and shall be within tolerance limits.
(Amended 1986)

T.N.4.3. Single Indicating Element/Multiple Indications. - In the case of an analog indicating element equipped with two or more indicating means within the same element, the difference in the weight indications for any load other than zero shall not be greater than one-half the value of the scale division (d) and be within tolerance limits.
(Amended 1986)

T.N.4.4. Shift or Section Tests. - The range of the results obtained during the conduct of a shift test or a section test shall not exceed the absolute value of the maintenance tolerance applicable and each test result shall be within applicable tolerances.
(Added 1986)

T.N.4.5. Time Dependence. - At constant test conditions, the indication 20 seconds after the application of a load and the indication after 1 hour shall not differ by more than:

- one-half of the absolute value of the applicable tolerance for the applied load for Class III L devices; and
 - the absolute value of the applicable tolerance for the applied load for all other devices.
- (Amended 1989)

T.N.5. Repeatability. - The results obtained from several weighings of the same load under reasonably static test conditions shall agree within the absolute value of the maintenance tolerance for that load, and shall be within applicable tolerances.

T.N.6. Sensitivity. - This section is applicable to all non-automatic-indicating scales marked I, II, III, III L, or IIII.

T.N.6.1. Test Load.

- (a) The test load for sensitivity for nonautomatic-indicating vehicle, axle-load, livestock, and animal scales shall be 1d for scales equipped with balance indicators, and 2d or 0.2 percent of the scale capacity, whichever is less, for scales not equipped with balance indicators.
- (b) For all other nonautomatic-indicating scales, the test load for sensitivity shall be 1d at zero and 2d at maximum test load.

T.N.6.2. Minimum Change of Indications. - The addition or removal of the test load for sensitivity shall cause a minimum permanent change as follows:

- (a) for a scale with trig loop but without a balance indicator, the position of the weighbeam shall change from the center to the outer limit of the trig loop;
- (b) for a scale with balance indicator, the position of the indicator shall change one division on the graduated scale, the width of the central target area, or the applicable value as shown below, whichever is greater;

Scale of Class I or II: 1 mm (0.04 in),

Scale of Class III or IIII with a maximum capacity of 30 kg (70 lb) or less: 2 mm (0.08 in),

Scale of Class III, III L, or IIII with a maximum capacity of more than 30 kg (70 lb): 5 mm (0.20 in);

- (c) for a scale without a trig loop or balance indicator, the position of rest of the weighbeam or lever system shall change from the horizontal or midway between limiting stops to either limit of motion.
- (Amended 1987)

T.N.7. Discrimination.

T.N.7.1. Analog Automatic Indicating (i.e., Weighing Device With Dial, Drum, Fan, Etc.). - A test load equivalent to 1.4d shall cause a change in the indication of at least 1.0d. (See N.1.5.)

T.N.7.2. Digital Automatic Indicating. - A test load equivalent to 1.4d shall cause a change in the indicated or recorded value of at least 2.0d. This requires the zone of uncertainty to be not greater than three-tenths of the value of the scale division. (See N.1.5.1.)

T.N.8. Influence Factors. - The following factors are applicable to tests conducted under controlled conditions only, provided that:

- (a) types of devices approved prior to January 1, 1986, and manufactured prior to January 1, 1988, need not meet the requirements of this section, and
 - (b) new types of devices submitted for approval after January 1, 1986, shall comply with the requirements of this section, and
 - (c) all devices manufactured after January 1, 1988, shall comply with the requirements of this section.
- (Amended 1985)

T.N.8.1. Temperature. - Devices shall satisfy the tolerance requirements under the following temperature conditions:

T.N.8.1.1. If not specified in the operating instructions for Class I or II scales, or if not marked on the device for Class III, III L, or IIII scales, the temperature limits shall be:

-10 °C to 40 °C (14 °F to 104 °F)

T.N.8.1.2. If temperature limits are specified for the device, the range shall be at least that specified in Table T.N.8.1.2.

Table T.N.8.1.2. Temperature Range by Class	
Class	Temperature Range
I	5 °C (9 °F)
II	15 °C (27 °F)
III, III L, & IIII	30 °C (54 °F)

T.N.8.1.3. Temperature Effect on Zero-Load Balance. - The zero-load indication shall not vary by more than:

- (a) three divisions per 5 °C (9 °F) change in temperature for Class III L devices; or
 - (b) one division per 5 °C (9 °F) change in temperature for all other devices.
- (Amended 1990)

T.N.8.1.4. Operating Temperature. - Except for Class I and II devices, an indicating or recording element shall not display nor record any usable values until the operating temperature necessary for accurate weighing and a stable zero balance condition have been attained.

T.N.8.2. Barometric Pressure. - Except for Class I scales, the zero indication shall not vary by more than one scale division for a change in barometric pressure of 1 kPa over the total barometric pressure range of 95 kPa to 105 kPa (28 to 31 in of Hg).

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T.N.8.3. Electric Power Supply.

(Added 1986)

T.N.8.3.1. Power Supply, Voltage and Frequency.

- (a) Weighing devices that operate using alternating current must perform within the conditions defined in paragraphs T.N.3. through T.N.7., inclusive from -15% to +10% of the marked nominal line voltage(s) at 60Hz, or the voltage range marked by the manufacturer, at 60 Hz.
(Amended 2003)

- (b) Battery operated instruments shall not indicate nor record values outside the applicable tolerance limits when battery power output is excessive or deficient.

T.N.8.3.2. Power Interruption. - A power interruption shall not cause an indicating or recording element to display or record any values outside the applicable tolerance limits.

T.N.9. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility. - The difference between the weight indication due to the disturbance and the weight indication without the disturbance shall not exceed one scale division (d); or the equipment shall:

- (a) blank the indication, or
- (b) provide an error message, or
- (c) the indication shall be so completely unstable that it cannot be interpreted, or transmitted into memory or to a recording element, as a correct measurement value.

The tolerance in T.N.9. is to be applied independently of other tolerances. For example, if indications are at allowable basic tolerance error limits when the disturbance occurs, then it is acceptable for the indication to exceed the applicable basic tolerances during the disturbance. [Editors' Note: Following the 1997 NCWM Annual Meeting, the text in this paragraph was revised with concurrence of the S&T Committee to clarify its application.]

(Amended 1997)

UR. User Requirements

UR.1. Selection Requirements. - Equipment shall be suitable for the service in which it is used with respect to elements of its design, including but not limited to, its capacity, number of scale divisions, value of the scale division or verification scale division, minimum capacity, and computing capability.⁴

UR.1.1. General.

- (a) For devices marked with a class designation, the typical class or type of device for particular weighing applications is shown in Table 7a.
- (b) For devices not marked with a class designation, Table 7b applies.

⁴ Purchasers and users of scales such as railway track, hopper, and vehicle scales should be aware of possible additional requirements for the design and installation of such devices.

(Footnote Added 1995)

Table 7a. Typical Class or Type of Device for Weighing Operations	
Class	Weighing Application or Scale Type
I	Precision laboratory weighing
II	Laboratory weighing, precious metals and gem weighing, grain test scales
III	All commercial weighing not otherwise specified, grain test scales, retail precious metals and semi-precious gem weighing, animal scales, postal scales, scales used to determine laundry charges, and vehicle on-board weighing systems
III L	Vehicle, axle-load, livestock, railway track scales, crane, hopper (other than grain hopper) scales, and vehicle on-board weighing systems
IIII	Wheel-load weighers and portable axle-load weighers used for highway weight enforcement
Note: A scale with a higher accuracy class than that specified as "typical" may be used. (Amended 1985, 1986, 1987, 1988, 1992, and 1995)	

Table 7b. Applicable to Devices Not Marked With a Class Designation	
Scale Type or Design	Maximum Value of d
Retail Food Scales, 50-lb capacity and less	1 ounce
Animal Scales	1 pound
Grain Hopper Scales Capacity up to and incl. 50 000 lb Capacity over 50 000 lb	10 pounds (but not greater than 0.05 % of capacity) 20 pounds
Crane Scales	not greater than 0.2 % of capacity
Vehicle and Axle-Load Scales Used in Combination Capacity up to and including 200 000 lb Capacity over 200 000 lb	20 pounds 50 pounds
Railway Track Scales With weighbeam Automatic indicating	20 pounds 100 pounds
Scales with capacities greater than 500 lb except otherwise specified	0.1 % capacity (but not greater than 50 lb)
Wheel-Load Weighers	.25 % capacity (but not greater than 50 lb)
Note: For scales not specified in this table, G-UR.1.1. and UR.1. apply. (Added 1985) (Amended 1989)	

UR.1.2. Grain Hopper Scales. - The minimum number of scale divisions for a Class III Hopper Scale used for weighing grain shall be 2 000.

UR.1.3. Value of the Indicated and Recorded Scale Division. - *The value of the scale division as recorded shall be the same as the division value indicated.*
(Added 1985) (Amended 1999)

UR.1.3.1. Exceptions. - *The provisions of UR.1.3. Value of the Indicated and Recorded Scale Division shall not apply to:*

(a) *Class I scales, or*

(b) *Dynamic monorail weighing systems when the value of d is less than the value of e.*

[Nonretroactive as of January 1, 1986.]

(Added 1999)

UR.1.4. Grain-Test Scales: Value of the Scale Divisions. - The scale division for grain-test scales shall not exceed 0.2 g for loads through 500 g, and shall not exceed 1 g for loads above 500 g through 1 000 g.
(Added 1992)

UR.1.5. Recording Element, Class III L Railway Track Scales. - *Class III L Railway Track Scales must be equipped with a recording element.*

[Nonretroactive as of January 1, 1996.]

(Added 1995)

UR.2. Installation Requirements.

UR.2.1. Supports. - A scale that is portable and that is being used on a counter, table, or the floor shall be so positioned that it is firmly and securely supported.

UR.2.2. Suspension of Hanging Scale. - A hanging scale shall be freely suspended from a fixed support when in use.

UR.2.3. Protection From Environmental Factors. - The indicating elements, the lever system or load cells, and the load-receiving element of a permanently installed scale, and the indicating elements of a scale not intended to be permanently installed, shall be adequately protected from environmental factors such as wind, weather, and RFI that may adversely affect the operation or performance of the device.

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UR.2.4. Foundation, Supports, and Clearance. - The foundation and supports of any scale installed in a fixed location shall be such as to provide strength, rigidity, and permanence of all components, and clearance shall be provided around all live parts to the extent that no contacts may result when the load-receiving element is empty, nor throughout the weighing range of the scale. *On vehicle and livestock scales, the clearance between the load-receiving elements and the coping at the bottom edge of the platform shall be greater than at the top edge of the platform.*

[Nonretroactive as of January 1, 1973.]

UR.2.5. Access to Weighing Elements. - Adequate provision shall be made for ready access to the pit of a vehicle, livestock, animal, axle-load, or railway track scale for the purpose of inspection and maintenance. Any of these scales without a pit shall be installed with adequate means for inspection and maintenance of the weighing elements.

(Amended 1985)

UR.2.6. Approaches.

UR.2.6.1. Vehicle Scales. [NOT ADOPTED]

UR.2.6.2. Axle-Load Scales. - At each end of an axle-load scale there shall be a straight paved approach in the same plane as the platform. The approaches shall be the same width as the platform and of sufficient length to insure the level positioning of vehicles during weight determinations.

UR.2.7. Stock Racks. - A livestock or animal scale shall be equipped with a suitable stock rack, with gates as required, which shall be securely mounted on the scale platform. Adequate clearances shall be maintained around the outside of the rack.

UR.2.8. Hoists. - On vehicle scales equipped with means for raising the load-receiving element from the weighing element for vehicle unloading, means shall be provided so that it is readily apparent to the scale operator when the load receiving element is in its designed weighing position.

UR.2.9. Provision for Testing Dynamic Monorail Weighing Systems. - Provisions shall be made at the time of installation of a dynamic monorail weighing systems for testing in accordance with N.1.3.6.1. (a rail around or other means for returning the test carcasses to the scale being tested).

[Nonretroactive as of January 1, 1998]

(Added 1997) (Amended 1999)

UR.3. Use Requirements.

UR.3.1. Recommended Minimum Load. - A recommended minimum load is specified in Table 8 since the use of a device to weigh light loads is likely to result in relatively large errors.

Table 8. Recommended Minimum Load		
Class	Value of scale division (d or e*)	Recommended minimum load (d or e*)
I	equal to or greater than 0.001 g	100
II	0.001 to 0.05 g, inclusive	20
	equal to or greater than 0.1 g	50
III	All**	20
III L	All	50
III	All	10
<p>* For Class I and II devices equipped with auxiliary reading means (i.e., a rider, a vernier, or a least significant decimal differentiated by size, shape or color), the value of the verification scale division "e" is the value of the scale division immediately preceding the auxiliary means. For Class III and III devices the value of "e" is specified by the manufacturer as marked on the device; "e" must be less than or equal to "d."</p> <p>** A minimum load of 10d is recommended for a weight classifier marked in accordance with a statement identifying its use for special applications. (Amended 1990)</p>		

UR.3.1.1. Minimum Load, Grain Dockage Determination. - When determining the quantity of foreign material (dockage) in grain, the weight of the sample shall be equal to or greater than 500 scale divisions.

(Added 1985)

UR.3.2. Maximum Load. - A scale shall not be used to weigh a load of more than the nominal capacity of the scale.

UR.3.2.1. Maximum Loading for Vehicle Scales. - A vehicle scale shall not be used to weigh loads exceeding the maximum load capacity of its span as specified in Table UR.3.2.1.

(Added 1996)

UR.3.3. Single-Draft Vehicle Weighing. - A vehicle or a coupled vehicle combination shall be commercially weighed on a vehicle scale only as a single draft. That is, the total weight of such a vehicle or combination shall not be determined by adding together the results obtained by separately and not simultaneously weighing each end of such vehicle or individual elements of such coupled combination. However:

- (a) the weight of a coupled combination may be determined by uncoupling the various elements (tractor, semitrailer, trailer), weighing each unit separately as a single draft, and adding together the results, or
- (b) the weight of a vehicle or coupled-vehicle combination may be determined by adding together the weights obtained while all individual elements are resting simultaneously on more than one scale platform.

[Note: This paragraph does not apply to highway-law-enforcement scales and scales used for the collection of statistical data.]

(Added 1992)

UR.3.4. Wheel-Load Weighing.

UR.3.4.1. Use in Pairs. - When wheel-load weighers or portable axle-load weighers are to be regularly used in pairs, both weighers of each such pair shall be appropriately marked to identify them as weighers intended to be used in combination.

UR.3.4.2. Level Condition. - A vehicle of which either an axle-load determination or a gross-load determination is being made utilizing wheel-load weighers or portable axle-load weighers, shall be in a reasonably level position at the time of such determination.

UR.3.5. Special Designs. - A scale designed and marked for a special application (such as a prepackaging scale or prescription scale with a counting feature) shall not be used for other than its intended purpose.⁴

(Amended 2003)

UR.3.6. Wet Commodities. - Wet commodities not in watertight containers shall be weighed only on a scale having a pan or platform that will drain properly.

(Amended 1988)

UR.3.7. Minimum Load on a Vehicle Scale.

[NOT ADOPTED]

4002.2. Scales (2.20.)

(b) Minimum Load on a Vehicle Scale. Except for weighments of ferrous metals, cardboard, paper, rags or plastic, and the weighing of vehicles for registration purposes, a vehicle scale shall not be used for weighing net loads less than the value of 20 scale divisions.

4002.2. Scales (2.20.)

(c) Class III, Class III L and Unmarked Devices Used For Recycling. Except for weighments of ferrous metals, cardboard, paper, rags, or plastic, Class III, Class III L and unmarked devices used in recycling shall not be used for weighing net loads less than the value of 20 scale divisions.

⁴ Prepackaging scales and prescription scales with a counting feature (and other commercial devices) used for putting up packages in advance of sale are acceptable for use in commerce only if all appropriate provisions of Handbook 44 are met. Users of such devices must be alert to the legal requirements relating to the declaration of quantity on a package. Such requirements are to the effect that, on the average, the contents of the individual packages of a particular commodity comprising a lot, shipment, or delivery must contain at least the quantity declared on the label. The fact that a prepackaging scale may overregister, but within established tolerances, and is approved for commercial service is not a legal justification for packages to contain, on the average, less than the labeled quantity.

(Amended 2003)

2.20. Scales

UR.3.8. Minimum Load for Weighing Livestock. - A scale with scale divisions greater than 2 kg (5 lb) shall not be used for weighing net loads smaller than 500d.
(Amended 1989)

UR.3.9. Use of Manual Gross Weight Entries. - Manual gross weight entries are permitted for use in the following applications only: (1) when credit is given for a weighed item on point-of-sale systems interfaced with scales; (2) when a device or system generates labels for standard weight packages; (3) when postal scales or weight classifiers generate manifests for packages to be picked up at a later time; or (4) when livestock and vehicle scale systems generate weight tickets to correct erroneous tickets.
(Added 1992) (Amended 2000)

UR.3.10. Dynamic Monorail Weighing Systems. - When the value of d is different from the value of e, the commercial transaction must be based on e.
(Added 1999)

UR.3.11. Minimum Count. - A prescription scale with an operational counting feature shall not be used to count a quantity of less than 30 pieces (weighing a minimum of 30 e).
(Added 2003)

UR.3.12. Correct Stored Piece Weight. - For prescription scales with a counting feature, the user is responsible for maintaining the correct stored piece weight. This is especially critical when a medicine has been reformulated or comes from different lots.
(Added 2003)

UR.4. Maintenance Requirements.

UR.4.1. Balance Condition. - The zero-load adjustment of a scale shall be maintained so that, with no load on the load-receiving element and with all load-counter-balancing elements of the scale (such as poises, drop weights, or counterbalance weights) set to zero, the scale shall indicate or record a zero balance condition. A scale not equipped to indicate or record a zero-load balance shall be maintained in balance under any no-load condition.

UR.4.2. Level Condition. - If a scale is equipped with a level-condition indicator, the scale shall be maintained in level.

UR.4.3. Scale Modification. - The dimensions (e.g., length, width, thickness, etc.) of the load receiving element of a scale shall not be changed beyond the manufacturer's specifications, nor shall the capacity of a scale be increased beyond its design capacity by replacing or modifying the original primary indicating or recording element with one of a higher capacity, except when the modification has been approved by a competent engineering authority, preferably that of the engineering department of the manufacturer of the scale, and by the weights and measures authority having jurisdiction over the scale.
(Amended 1996)

UR.5. Coupled-in-Motion Railroad Weighing Systems. - A coupled-in-motion weighing system placed in service on or after January 1, 1991, should be tested in the manner in which it is operated, with the locomotive either pushing or pulling the cars at the designed speed and in the proper direction. The cars used in the test train should represent the range of gross weights that will be used during the normal operation of the weighing system. Except as provided in N.4.2. and N.4.3.(a), normal operating procedures should be simulated as nearly as practical. Approach conditions for a train length in each direction of the scale site are more critical for a weighing system used for individual car weights than for a unit-train-weights-only facility, and should be considered prior to installation.
(Added 1990) (Amended 1992)

- (b) Vent lines from the air or vapor eliminator shall be made of metal tubing or other rigid material.
(Amended 1975)

S.2.1.1. Vapor Elimination on Loading Rack Metering Systems.

- (a) A loading rack metering system shall be equipped with a vapor or air eliminator or other automatic means to prevent the passage of vapor and air through the meter unless the system is designed or operationally controlled by a method, approved by the weights and measures jurisdiction having control over the device, such that air and/or vapor cannot enter the system.

- (b) Vent lines from the air or vapor eliminator (if present) shall be made of metal tubing or other rigid material.
(Added 1994)

S.2.2. Provision for Sealing. - Adequate provision shall be made for an approved means of security (e.g., data change audit trail) or for physically applying a security seal in such a manner that requires the security seal to be broken before an adjustment can be made of:

- (a) any measurement element, or
- (b) any adjustable element for controlling delivery rate when such rate tends to affect the accuracy of deliveries.

When applicable, the adjusting mechanism shall be readily accessible for purposes of affixing a security seal.

*Audit trails shall use the format set forth in Table S.2.2.
[Nonretroactive as of January 1, 1995.]*
(Amended 1991, 1993, 1995 and 2003)

S.2.3. Directional Flow Valves. - Valves intended to prevent reversal of flow shall be automatic in operation.

S.2.4. Stop Mechanism.

S.2.4.1. Indication. - The delivery for which the device is set shall be conspicuously indicated.
(Amended 1983)

S.2.4.2. Stroke Limiting Elements. - Stops or other stroke limiting elements subject to direct pressure or impact shall be:

- (a) made secure by positive, nonfrictional engagement of these elements; and

- (b) adjustable to provide for deliveries within tolerances.
(Amended 1983)

S.2.4.3. Setting. - If two or more stops or other elements may be selectively brought into operation to permit predetermined quantities of deliveries,

- (a) the position for the proper setting of each such element shall be accurately defined; and
- (b) any inadvertent displacement from the proper setting shall be obstructed.
(Amended 1983)

S.2.5. Zero-Set-Back Interlock, Retail Motor-Fuel Devices. - A device shall be constructed so that:

- (a) after a delivery cycle has been completed by moving the starting lever to any position that shuts off the device, an automatic interlock prevents a subsequent delivery until the indicating elements, and recording elements if the device is equipped and activated to record, have been returned to their zero positions;
- (b) the discharge nozzle cannot be returned to its designed hanging position (that is, any position where the tip of the nozzle is placed in its designed receptacle and the lock can be inserted) until the starting lever is in its designed shut-off position and the zero-set-back interlock has been engaged; and
- (c) in a system with more than one dispenser supplied by a single pump, an effective automatic control valve in each dispenser prevents product from being delivered until the indicating elements on that dispenser are in a correct zero position.
(Amended 1981 and 1985)

S.2.6. Temperature Determination and Wholesale Devices. *For test purposes, means shall be provided to determine the temperature of the liquid either:*

- (a) *in the liquid chamber of the meter, or*
- (b) *immediately adjacent to the meter in the meter inlet or discharge line.*

[Nonretroactive as of January 1, 1985.]
(Added 1984) (Amended 1986)

S.2.7. Wholesale Devices Equipped with Automatic Temperature Compensators.

3.30. Liquid-Measuring Devices

Table S.2.2. Categories of Device and Methods of Sealing	
<i>Categories of Device</i>	<i>Method of Sealing</i>
<i>Category 1: No remote configuration capability.</i>	<i>Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.</i>
<p><i>Category 2: Remote configuration capability, but access is controlled by physical hardware.</i></p> <p><i>Device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode.</i></p> <p><i>[Category 2 applies only to devices manufactured prior to January 1, 2005. Devices with remote configuration capability manufactured after that date must meet the sealing requirements outlined in Category 3. Devices without remote configuration capability manufactured after that date will be required to meet the minimum criteria outlined in Category 1.]</i></p>	<p><i>[The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.]*</i></p> <p><i>[*Nonretroactive as of January 1, 1996]</i></p>
<p><i>Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password).</i></p> <p>The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.</p> <p>[Nonretroactive as of January 1, 2001]</p> <p><i>Nonretroactive as of January 1, 2005, all devices with remote configuration capability must comply with the sealing requirement of Category 3.</i></p>	<p><i>An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to ten times the number of sealable parameters in the device, but not more than 1000 records are required. <u>(Note: Does not require 1000 changes to be stored for each parameter.)</u></i></p>

[Nonretroactive as of January 1, 1995.] (Table added 1993) (Amended 1995, 1998, and 1999)

S.2.7.1. Automatic Temperature Compensation. -

A device may be equipped with an automatic means for adjusting the indication and registration of the measured volume of product to the volume at 15°C (60°F).

S.2.7.2. Provision for Deactivating. - On a device equipped with an automatic temperature-compensating mechanism that will indicate or record only in terms of gallons compensated to 15°C (60°F), provision shall be made for deactivating the automatic temperature-compensating mechanism so that the meter can indicate, and record if it is equipped to record, in terms of the uncompensated volume.
(Amended 1972)

S.2.7.3. Provision for Sealing Automatic Temperature Compensating Systems. -

Provision shall be made for applying security seals in such a manner that an automatic temperature-compensating system cannot be disconnected and that no adjustment may be made to the system without breaking the seal.

S.2.7.4. Temperature Determination with Automatic Temperature Compensation. -

For test purposes, means shall be provided (e.g., thermometer well) to determine the temperature of the liquid either:

- (a) in the liquid chamber of the meter, or
 - (b) immediately adjacent to the meter in the meter inlet or discharge line.
- (Amended 1987)

S.2.8. Exhaustion of Supply, Lubricant Devices Other Than Meter Types. - When the level of the supply of lubricant becomes so low as to compromise the accuracy of measurement, the device shall:

- (a) become inoperable automatically, or
- (b) give a conspicuous and distinct warning.

S.3. Discharge Lines and Valves.

S.3.1. Diversion of Measured Liquid. - No means shall be provided by which any measured liquid can be diverted from the measuring chamber of the meter or its discharge line. Two or more delivery outlets may be installed only if automatic means are provided to ensure that:

- (a) liquid can flow from only one outlet at a time, and
- (b) the direction of flow for which the mechanism may be set at any time is clearly and conspicuously indicated.

A manually controlled outlet that may be opened for purging or draining the measuring system or for recirculating product in suspension shall be permitted only when the system is measuring food products or agri-chemicals. Effective means shall be provided to prevent passage of liquid through any such outlet during normal operation of the measuring system and to inhibit meter indications (or advancement of indications) and recorded representations while the outlet is in operation.
(Amended 1991, 1995, and 1996)

S.3.2. Exceptions. - The provisions of S.3.1. Diversion Prohibited shall not apply to truck refueling devices when diversion of flow to other than the receiving vehicle cannot readily be accomplished and is readily apparent. Allowable deterrents include, but are not limited to, physical barriers to adjacent driveways, visible valves, or lighting systems that indicate which outlets are in operation, and explanatory signs.
(Amended 1982, 1990, 1991 and 2002)

S.3.3. Pump-Discharge Unit. - A pump-discharge unit equipped with a flexible discharge hose shall be of the wet-hose type.

S.3.4. Gravity-Discharge Unit. - On a gravity-discharge unit:

- (a) the discharge hose or equivalent pipe shall be of the dry-hose type with no shutoff valve at its outlet end unless the hose or pipe drains to the same level under all conditions of use;

- (b) the dry hose shall be sufficiently stiff and only as long as necessary to facilitate drainage;
- (c) an automatic vacuum breaker, or equivalent mechanism, shall be incorporated to prevent siphoning and to ensure rapid and complete drainage; and
- (d) the inlet end of the hose or outlet pipe shall be high enough to ensure complete drainage.

S.3.5. Discharge Hose, Reinforcement. - A discharge hose shall be reinforced so that the performance of the device is not affected by the expansion or contraction of the hose.

S.3.6. Discharge Valve. - A discharge valve may be installed in the discharge line only if the device is of the wet-hose type. Any other shutoff valve on the discharge side of the meter shall be of the automatic or semi-automatic predetermined-stop type or shall be operable only:

- (a) by means of a tool (but not a pin) entirely separate from the device, or
- (b) by mutilation of a security seal with which the valve is sealed open.

S.3.7. Antidrain Means. - In a wet-hose pressure-type device, means shall be incorporated to prevent the drainage of the discharge hose.
(Amended 1990)

S.4. Marking Requirements.

S.4.1. Limitation on Use. - The limitations on its use shall be clearly and permanently marked on any device intended to measure accurately only:

- (a) products having particular properties; or
- (b) under specific installation or operating conditions; or
- (c) when used in conjunction with specific accessory equipment.

S.4.2. Air Pressure. - If a device is operated by air pressure, the air pressure gauge shall show by special graduations or other means the maximum and minimum working pressures recommended by the manufacturer.

S.4.3. Wholesale Devices.

S.4.3.1. Discharge Rates. - A wholesale device shall be marked to show its designed maximum and minimum discharge rates. However, the minimum discharge rate shall not exceed 20 percent of the maximum discharge rate.

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S.4.3.2. Temperature Compensation. - If a device is equipped with an automatic temperature compensator, the primary indicating elements, recording elements, and recorded representation shall be clearly and conspicuously marked to show that the volume delivered has been adjusted to the volume at 15 °C (60 °F).

S.4.4. Retail Devices.

S.4.4.1. Discharge Rates. - *On a retail device with a designed maximum discharge rate of 115 L (30 gal) per minute or greater, the maximum and minimum discharge rates shall be marked in accordance with S.4.4.2. The marked minimum discharge rate shall not exceed 20% of the marked maximum discharge rate.*

[Nonretroactive as of January 1, 1985.]

(Added 1984) (Amended 2002 and 2003)

Example: With a marked maximum discharge rate of 230 L/min (60 gpm), the marked minimum discharge rate shall be 45 L/min (12 gpm) or less (e.g., 40 L/min (10 gpm) is acceptable). A marked minimum discharge rate greater than 45 L/min (12 gpm) (e.g., 60 L/min [15 gpm]) is not acceptable.

(Added 2003)

S.4.4.2. Location of Marking Information; Retail Motor-Fuel Dispensers. - *The required marking information in the General Code, Paragraph G-S.1. shall appear as follows:*

- (a) *Placement of this information shall not be on a portion of the device that can be readily removed or interchanged without the use of a tool separate from the device.*
- (b) *The information shall appear 24 inches to 60 inches from the base of the dispenser when placed on the outside of the device.*
- (c) *When placed behind an access door or panel the information shall appear 24 inches to 60 inches from the base of the dispenser in a readily legible position. The use of a dispenser key shall not be considered a tool separate from the device.*

[Nonretroactive as of January 1, 2003]

(Added 2002)

S.5. Totalizers for Retail Motor-Fuel Dispensers. - *Retail motor-fuel dispensers shall be equipped with a nonresettable totalizer for the quantity delivered through the metering device.*

[Nonretroactive as of January 1, 1995.]

(Added 1993) (Amended 1994 and 1997)

N. Notes

N.1. Test Liquid.

N.1.1. Type of Liquid. - The liquid used for testing a liquid-measuring device shall be the type the device is used to measure, or another liquid with the same general physical characteristics.

N.1.2. Labeling. - Following the completion of a successful examination of a wholesale device, the weights and measures official should attach a label or tag indicating the type of liquid used during the test.

N.2. Volume Change. - Care shall be taken to minimize changes in volume of the test liquid due to temperature changes and evaporation losses.

N.3. Test Drafts.

N.3.1. Retail Piston-Type and Visible-Type Devices. - Test drafts shall include the full capacity delivery and each intermediate delivery for which the device is designed.

N.3.2. Slow Flow Meters. - Test drafts shall be equal to at least four times the minimum volume that can be measured and indicated through either a visible indication or an audible signal.

N.3.3. Lubricant Devices. - Test drafts shall be 1 L (1 qt). Additional test drafts may include 0.5 L (1 pt), 4 L (4 qt), and 6 L (6 qt).

N.3.4. Other Retail Devices. - On devices with a designed maximum discharge rate of:

- (a) less than 80 L (20 gal) per minute, tests shall include drafts of one or more amounts, including a draft of at least 19 liters (5 gal).
- (b) 80 L (20 gal) per minute or greater, tests shall include drafts of one or more amounts, including a draft of at least the amount delivered by the device in one minute at the maximum flow rate of the installation.
(Amended 1984)

N.3.5. Wholesale Devices. - The delivered quantity should be equal to at least the amount delivered by the device in one minute at its maximum discharge rate, and shall in no case be less than 200 L (50 gal).
(Amended 1987 and 1996)

N.4. Testing Procedures.

N.4.1. Normal Tests. - The "normal" test of a device shall be made at the maximum discharge flow rate developed under the conditions of installation. Any

additional tests conducted at flow rates down to and including one-half of the sum of the maximum discharge flow rate and the rated minimum discharge flow rate shall be considered normal tests.
(Amended 1991)

N.4.1.1. Wholesale Devices Equipped with Automatic Temperature-Compensating Systems.

[NOT ADOPTED]

N.4.1.2. Repeatability Tests. - Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors, such as temperature, pressure, and flow rate are reduced to the extent that they will not affect the results obtained.
(Added 2001)

4002.8. Liquid-Measuring Devices. (3.30.)

(a) Wholesale Devices Equipped With Automatic Temperature Compensating Systems. On wholesale devices equipped with automatic temperature compensating systems, normal tests:

- (1) shall be conducted with the temperature compensating system connected and operating by comparing the compensated volume indicated or recorded to the actual delivered volume corrected to 60°F, and**
- (2) may be conducted with the temperature compensating system deactivated by comparing the uncompensated volume indicated or recorded to the actual delivered volume.**

The first test shall be performed with the automatic temperature compensating system operating in the “as found” condition.

On devices that indicate or record both the compensated and uncompensated volume for each delivery, the tests in (1) and (2) may be performed as a single test.

N.4.2. Special Tests. - “Special” tests, to develop the operating characteristics of a liquid-measuring device and any special elements and accessories attached to or associated with the device, shall be made as circumstances

require. Any test except as set forth in N.4.1. shall be considered a special test.

N.4.2.1. Slow-Flow Meters. - A “special” test shall be made at a flow rate:

- (a) not larger than twice the actual minimum flow rate, and
- (b) not smaller than the actual minimum flow rate of the installation.

N.4.2.2. Retail Motor-Fuel Devices.

(a) Devices with a flow-rate capacity less than 100 (25 gal) per minute shall have a “special” test performed at the slower of the following rates:

- (1) 19 L (5 gal) per minute, or
- (2) the minimum discharge rate marked on the device, or
- (3) the minimum discharge rate at which the device will deliver when equipped with an automatic discharge nozzle set at its slowest setting.

(b) Devices marked with a flow-rate capacity 100 L (25 gal) or more per minute, shall have a “special” test performed at the slowest of the following rates:

- (1) the minimum discharge rate marked on the device, or
- (2) the minimum discharge rate at which the device will deliver when equipped with an automatic discharge nozzle set at its slowest setting.

(Added 1984)

N.4.2.3. Other Retail Devices. - “Special” tests of other retail devices shall be made at the slower of the following rates:

- (a) 50 percent of the maximum discharge rate developed under the conditions of installation, or
- (b) the minimum discharge rate marked on the device.

N.4.2.4. Wholesale Devices. - “Special” tests shall be made to develop the operating characteristics of a measuring system and any special associated or attached elements and accessories. “Special” tests shall include a test at the slower of the following rates:

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- (a) 20 percent of the marked maximum discharge rate;
or
- (b) the minimum discharge rate marked on the device.

N.4.3. Money-Value Computation Tests.

N.4.3.1. Laboratory Tests. - When testing the device in the laboratory:

- (a) compliance with paragraph S.1.6.5., Money Value Computations, shall be determined by using the cone gear as a reference for the total quantity delivered;
- (b) the indicated quantity shall agree with the cone gear representation with the index of the indicator within the width of the graduation; and
- (c) the maximum allowable variation of the indicated sales price shall be as shown in Table 1.
(Amended 1984)

N.4.3.2. Field Tests. - In the conduct of field tests to determine compliance with paragraph S.1.6.5., the maximum allowable variation in the indicated sales

price shall be as shown in Table 1.
(Added 1982; Amended 1984)

N.5. Temperature Correction on Wholesale Devices. - Corrections shall be made for any changes in volume resulting from the differences in liquid temperatures between time of passage through the meter and time of volumetric determination in the prover. When adjustments are necessary, appropriate petroleum measurement tables should be used.
(Amended 1974)

T. Tolerances

T.1. Application to Underregistration and to Over-registration. The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of over-registration, whether or not a device is equipped with an automatic temperature compensator.

T.2. Tolerance Values. - Maintenance, Acceptance, and Special Test Tolerances shall be as shown in Table T.2.
(Amended 2002)

**Table T.2. Accuracy Classes for Liquid Measuring Devices Covered in
NIST Handbook 44 Section 3.30**

Accuracy Class	Application	Acceptance Tolerance	Maintenance Tolerance	Special Test Tolerance
0.3	Petroleum products including large capacity motor fuel devices (flow rates over 115 L/min (30 gpm))**, heated products at or greater than 50 °C asphalt at or below temperatures 50 °C, all other liquids not shown where the typical delivery is over 200 L (50 gal).	0.2 %	0.3 %	0.5 %
0.3A	Asphalt at temperatures greater than 50 °C.	0.3 %	0.3 %	0.5 %
0.5*	Petroleum products delivered from small capacity (at 4 L/min (1 gpm) through 115 L/min (30 gpm))** motor-fuel devices, agri-chemical liquids, and all other applications not shown.	0.3 %	0.5 %	0.5 %
1.1	Petroleum products and other normal liquids from devices with flow rates** less than 1 gpm and devices designed to deliver less than one gallon.	0.75 %	1.0 %	1.25 %
* For 5-gallon and 10-gallon test drafts, the tolerances specified for Accuracy Class 0.5 in the table above do not apply. For these test drafts, the maintenance tolerances on normal and special tests for 5-gallon and 10-gallon test drafts are 6 cubic inches and 11 cubic inches, respectively. Acceptance tolerances on normal and special tests are 3 cubic inches and 5.5 cubic inches.				
** Flow rate refers to designed or marked maximum flow rate.				

(Added 2002) (Amended 2003)

T.3. Repeatability. - When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 percent of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance. This tolerance does not apply to the test of the automatic temperature compensating system. See also N.4.1.2.
(Added 1992) (Amended 2001 and 2002)

T.4. Automatic Temperature Compensating Systems. - *The difference between the meter error (expressed as a percentage) for results determined with and without the automatic temperature compensating system activated shall not exceed:*

- (a) *0.2 percent for mechanical automatic temperature compensating systems; and*
- (b) *0.1 percent for electronic automatic temperature compensating systems.*

The delivered quantities for each test shall be approximately the same size. The results of each test shall be within the applicable acceptance or maintenance tolerance.
[Nonretroactive as of January 1, 1988.]
(Added 1987) (Amended 199, 1996 and 2002)

UR. User Requirements

UR.1. Selection Requirements.

UR.1.1. Discharge Hose.

UR.1.1.1. Length. - The length of the discharge hose on a retail motor-fuel device:

- (a) shall be measured from its housing or outlet of the discharge line to the inlet of the discharge nozzle;
- (b) shall be measured with the hose fully extended if it is coiled or otherwise retained or connected inside a housing; and
- (c) shall not exceed 5.5 m (18 ft) unless it can be demonstrated that a longer hose is essential to permit deliveries to be made to receiving vehicles or vessels.

An unnecessarily remote location of a device shall not be accepted as justification for an abnormally long hose.
(Amended 1972 and 1987)

UR.1.1.2. Marinas and Airports.

UR.1.1.2.1. Length. - The length of the discharge hose shall be as short as practicable, and shall not exceed 15 m (50 ft) unless it can be demonstrated that a longer hose is essential.

UR.1.1.2.2. Protection. - Discharge hoses exceeding 8 m (26 ft) in length shall be adequately protected from weather and other environmental factors when not in use.
(Made retroactive 1974 and amended 1984)

UR.2. Installation Requirements.

UR.2.1. Manufacturer's Instructions. - A device shall be installed in accordance with the manufacturer's instructions, and the installation shall be sufficiently secure and rigid to maintain this condition.
(Added 1987)

UR.2.2. Discharge Rate. - A device shall be installed so that the actual maximum discharge rate will not exceed the rated maximum discharge rate. Automatic means for flow regulation shall be incorporated in the installation if necessary.

UR.2.3. Suction Head. - A piston-type device shall be installed so that the total effective suction head will not be great enough to cause vaporization of the liquid being dispensed under the highest temperature and lowest barometric pressure likely to occur.

UR.2.4. Diversion of Liquid Flow. - A motor-fuel device equipped with two delivery outlets used exclusively in the fueling of trucks shall be so installed that any diversion of flow to other than the receiving vehicle cannot be readily accomplished and is readily apparent. Allowable deterrents include, but are not limited to, physical barriers to adjacent driveways, visible valves, or lighting systems that indicate which outlets are in operation, and explanatory signs.
(Amended 1991)

UR.2.5. Product Storage Identification.

- (a) The fill connection for any petroleum product storage tank or vessel supplying motor-fuel devices shall be permanently, plainly, and visibly marked as to product contained.
- (b) When the fill connection device is marked by means of a color code, the color code key shall be conspicuously displayed at the place of business.
(Added 1975 and amended 1976)

UR.3. Use of Device.

UR.3.1. Return of Indicating and Recording Elements to Zero. - On any dispenser used in making retail deliveries, the primary indicating element, and recording element if so equipped, shall be returned to zero before each delivery.

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Exceptions to this requirement are totalizers on key-lock-operated or other self-operated dispensers and the primary recording element if the device is equipped to record.

UR.3.2. Unit Price and Product Identity.

- (a) The following information shall be conspicuously displayed or posted on the face of a retail dispenser used in direct sale:
 - (1) except for dispensers used exclusively for fleet sales, other price contract sales, and truck refueling (e.g., truck stop dispensers used only to refuel trucks), all of the unit prices at which the product is offered for sale; and
 - (2) in the case of a computing type or money-operated type, the unit price at which the dispenser is set to compute.

Provided that the dispenser complies with S.1.6.4.1., it is not necessary that all the unit prices for all grades, brands, blends, or mixtures be simultaneously displayed or posted.

- (b) The following information shall be conspicuously displayed or posted on each side of a retail dispenser used in direct sale:
 - (1) the identity of the product in descriptive commercial terms, and
 - (2) the identity of the grade, brand, blend, or mixture that a multi-product dispenser is set to deliver.
(Amended 1972, 1983, 1987, 1989, 1992, and 1993)

UR.3.3. Computing Device.

- (a) Any computing device used in an application where a product or grade is offered for sale at more than one unit price (excluding fleet sales and other price contract sales), shall be used only for sales for which the device computes and displays the sales price for the selected transaction.
[Became Retroactive 1999]
(Added 1989) (Amended 1992 and 2000)
- (b) A truck stop dispenser used exclusively for refueling trucks is exempt from the requirements in (a) and (b) if all purchases of fuel are accompanied by a printed receipt of the transaction containing the applicable price per gallon, the total gallons delivered, and the total price of the sale.
(Added 1993)

- (c) Unless a truck stop dispenser used exclusively for refueling trucks complies with S.1.6.4.1. (Display of Unit Price), the price posted on the dispenser and the price at which the dispenser is set to compute shall be the highest price for any transaction which may be conducted.
(Added 1993)

UR.3.4. Printed Ticket. - The total price, the total volume of the delivery, and the price per gallon or liter shall be shown, either printed or in clear hand script, on any printed ticket issued by a device and containing any one of these values.
(Amended 2001)

UR.3.5. Steps After Dispensing. - After delivery to a customer from a retail motor-fuel device:

- (a) the starting lever shall be returned to its shutoff position and the zero-set-back interlock engaged; and
- (b) the discharge nozzle shall be returned to its designed hanging position unless the primary indicating elements, and recording elements if the device is equipped and activated to record, have been returned to a definite zero indication.

UR.3.6. Temperature Compensation, Wholesale.

UR.3.6.1. Automatic.

UR.3.6.1.1. When to be Used. - If a device is equipped with a mechanical automatic temperature compensator, it shall be connected, operable, and in use at all times. An electronic or mechanical automatic temperature compensating system may not be removed, nor may a compensated device be replaced with an uncompensated device, without the written approval of the responsible weights and measures jurisdiction.

[Note: This requirement does not specify the method of sale for product measured through a meter.]
(Amended 1989)

UR.3.6.1.2. Invoices.

- (a) A written invoice based on a reading of a device that is equipped with an automatic temperature compensator shall show that the volume delivered has been adjusted to the volume at 15 °C (60 °F).

- (b) The invoice issued from an electronic wholesale device equipped with an automatic temperature compensating system shall also indicate: (1) the API gravity, specific gravity or coefficient of expansion for the product; (2) product temperature; and (3) gross reading.

(Amended 1987)

UR.3.6.2. Nonautomatic.

UR.3.6.2.1. Temperature Determination. - If the volume of the product delivered is adjusted to the volume at 15 °C (60 °F), the product temperature shall be taken during the delivery in:

- (a) the liquid chamber of the meter, or
- (b) the meter inlet or discharge line adjacent to the meter, or
- (c) the compartment of the receiving vehicle at the time it is loaded.

UR.3.6.2.2. Invoices. - The accompanying invoice shall indicate that the volume of the product has been adjusted for temperature variations to a volume at 15 °C (60 °F) and shall also state the product temperature used in making the adjustment.

UR.3.6.3. Period of Use. – When fuel is bought or sold on an automatic or nonautomatic temperature-compensated basis, it shall be bought or sold using this method over at least a consecutive 12-month period, unless otherwise agreed to by both the buyer and seller in writing.

(Added 2003)

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S.2.2. Provision for Sealing. - Except on devices for metering milk, adequate provision shall be made for applying security seals in such a manner that no adjustment may be made of:

- (a) any measurement element, and
- (b) any adjustable element for controlling delivery rate when such rate tends to affect the accuracy of deliveries.

S.2.2.1. Milk-Metering Systems. - Adequate provision shall be made for applying security seals to the adjustment mechanism and the register. The adjusting mechanism shall be readily accessible for purposes of affixing a security seal.

S.2.3. Directional Flow Valves. - Valves intended to prevent reversal of flow shall be automatic in operation. However, on equipment used exclusively for fueling aircraft, such valves may be manual in operation.

S.3. Design of Discharge Lines and Discharge Line Valves. (Not applicable to milk-metering systems.)

S.3.1. Diversion of Measured Liquid. - Except on equipment used exclusively for fueling aircraft, no means shall be provided by which any measured liquid can be diverted from the measuring chamber of the meter or the discharge line therefrom. However, two or more delivery outlets may be installed if means is provided to insure that:

- (a) liquid can flow from only one such outlet at one time, and
- (b) the direction of flow for which the mechanism may be set at any time is definitely and conspicuously indicated.

S.3.2. Pump-Discharge Unit. - On a pump-discharge unit, the discharge hose shall be of the wet-hose type with a shutoff valve at its outlet end. However, a pump-discharge unit may be equipped also with a dry hose without a shutoff valve at its outlet end, but only if:

- (a) the dry hose is as short as practicable, and
- (b) there is incorporated in the discharge piping, immediately adjacent to the meter, effective means to insure that liquid can flow through only one of the discharge hoses at any one time and that the meter and the wet hose remain full of liquid at all times.

S.3.3. Gravity-Discharge Unit. - On a gravity-discharge unit, the discharge hose or equivalent pipe shall be of the dry-hose type with no shutoff valve at its outlet end. The dry hose shall be of such stiffness and only of such length as to facilitate its drainage. The inlet end of the hose or of an equivalent outlet pipe shall be of such height as to

provide for proper drainage of the hose or pipe. There shall be incorporated an automatic vacuum breaker or equivalent means to prevent siphoning and to insure the rapid and complete drainage.

S.3.4. Discharge Hose. - A discharge hose shall be adequately reinforced.

S.3.5. Discharge Valve. - A discharge valve may be installed in the discharge line only if the device is of the wet-hose type, in which case such valve shall be at the discharge end of the line. Any other shutoff valve on the discharge side of the meter shall be of the automatic or semiautomatic predetermined-stop type or shall be operable only:

- (a) by means of a tool (but not a pin) entirely separate from the device, or
- (b) by mutilation of a security seal with which the valve is sealed open.

S.3.6. Antidrain Valve. - In a wet-hose, pressure-type device, an effective antidrain valve shall be incorporated in the discharge valve or immediately adjacent thereto. The antidrain valve shall function so as to prevent the drainage of the discharge hose. However, a device used exclusively for fueling and defueling aircraft may be of the pressure type without an antidrain valve.

S.4. Design of Intake Lines (for Milk-Metering Systems).

S.4.1. Diversion of Liquid to be Measured. - No means shall be provided by which any liquid can be diverted from the supply tank to the receiving tank without being measured by the device.

S.4.2. Intake Hose. - The intake hose shall be:

- (a) of the dry-hose type;
- (b) adequately reinforced;
- (c) not more than 6 m (20 ft) in length, unless it can be demonstrated that a longer hose is essential to permit pickups from a supply tank; and
- (d) connected to the pump at horizontal or above, to permit complete drainage of the hose.

S.5. Marking Requirements

S.5.1. Limitation of Use. - If a meter is intended to measure accurately only liquids having particular properties, or to measure accurately only under specific installation or operating conditions, or to measure

3.31. Vehicle-Tank Meters

accurately only when used in conjunction with specific accessory equipment, these limitations shall be clearly and permanently stated on the meter.

S.5.2. Discharge Rates. - A meter shall be marked to show its designed maximum and minimum discharge rates. However, the minimum discharge rate shall not exceed 20% of the maximum discharge rate.

Note: See example in Section 3.30. Liquid-Measuring Devices Code, paragraph S.4.4.1.
(Added 2003)

S.5.3. Measuring Components Milk-Metering System. All components that affect the measurement of milk that are disassembled for cleaning purposes shall be clearly and permanently identified with a common serial number.

S.5.4. Flood Volume, Milk-Metering System. - When applicable, the volume of product necessary to flood the system when dry shall be clearly, conspicuously, and permanently marked on the air eliminator.

S.5.5. Conversion Factor. - When the conversion factor of 1.03 kg/L (8.6 lb/gal) is used to convert the volume of milk to weight, the conversion factor shall be clearly marked on the primary indicating element and recorded on the delivery ticket.
(Added 1989)

N. Notes

N.1. Test Liquid.

- (a) A measuring system shall be tested with the liquid to be commercially measured or with a liquid of the same general physical characteristics. Following a satisfactory examination, the weights and measures official should attach a seal or tag indicating the product used during the test.
(Amended 1975)
- (b) A milk measuring system shall be tested with the type of milk to be measured when the accuracy of the system is affected by the characteristics of milk (e.g., positive displacement meters).
(Amended 1989)

N.2. Evaporation and Volume Change. - Care shall be exercised to reduce to a minimum, evaporation losses and volume changes resulting from changes in temperature of the test liquid.

N.3. Test Drafts. - Test drafts should be equal to at least the amount delivered by the device in 1 minute at its maximum discharge rate, and shall in no case be less than 180 L (50 gal) or 225 kg (500 lb).
(Amended 1989)

N.4. Testing Procedures

N.4.1. Normal Tests. - The “normal” test of a measuring system shall be made at the maximum discharge rate that may be anticipated under the conditions of the installation. Any additional tests conducted at flow rates down to and including one-half of the sum of the maximum discharge flow rate and the rated minimum discharge flow rate shall be considered normal tests.

(Amended 1992)

N.4.1.1. Milk Measuring System. - The “normal” test shall include a determination of the effectiveness of the air elimination system.

N.4.1.2. Repeatability Tests. - Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors such as, temperature pressure and flow rate are reduced to the extent that they will not affect the results obtained.

(Added 2001)

N.4.2. Special Tests (Except Milk-Measuring Systems). “Special” tests shall be made to develop the operating characteristics of a measuring system and any special elements and accessories attached to or associated with the device. Any test except as set forth in N.4.1. shall be considered a special test. Special test of a measuring system shall be made as follows:

- (a) at a minimum discharge rate of 20 percent of the marked maximum discharge rate or at the minimum discharge rate marked on the device whichever is less;
- (b) to develop operating characteristics of the measuring system during a split-compartment delivery.
(Amended 1978)

N.4.3. Antidrain Valve Test. - The effectiveness of the antidrain valve shall be tested after the pump pressure in the measuring system has been released and a valve between the supply tank and the discharge valve is closed.

N.4.4. System Capacity. - The test of a milk-measuring system shall include the verification of the volume of product necessary to flood the system as marked on the air eliminator.

T. Tolerances

T.1. Application.

T.1.1. To Underregistration and to Overregistration. The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration.

T.2. Tolerance Values. - Maintenance, acceptance, and special test tolerances shall be as shown in Tables 1 and 2.
(Amended 1995 and 2002)

Tolerances, Table 1. Accuracy Classes for Vehicle-Tank Meters					
Accuracy Class	Application		Acceptance Tolerance	Maintenance Tolerance	Special Test Tolerance
0.3	Petroleum products including large capacity motor fuel devices (flow rates over 115 L/min (30 gpm))**, heated products at or greater than 50 °C asphalt at or below temperatures 50 °C, all other liquids not shown where the typical delivery is over 200 L (50 gal).		0.15 %	0.3 %	0.45 %
0.3A	Asphalt at temperatures greater than 50 °C.		0.3 %	0.3 %	0.5 %
0.5*	Petroleum products delivered from small capacity (at 4 L/min (1 gpm) through 115 L/min (30 gpm))** motor-fuel devices, agri-chemical liquids, and all other applications not shown.		0.3 %	0.5 %	0.5 %
1.1	Petroleum products and other normal liquids from devices with flow rates** less than 1 gpm and devices designed to deliver less than one gallon.		0.75 %	1.0 %	1.25 %
1.5	Water	Overregistration	1.5 %	1.5 %	1.5 %
		Underregistration	1.5 %	1.5 %	5.0 %
<p>* For 5-gallon and 10-gallon test drafts, the tolerances specified for Accuracy Class 0.5 in the table above do not apply. For these test drafts, the maintenance tolerances on normal and special tests for 5-gallon and 10-gallon test drafts are 6 cubic inches and 11 cubic inches, respectively. Acceptance tolerances on normal and special tests are 3 cubic inches and 5.5 cubic inches.</p> <p>** Flow rate refers to designed or marked maximum flow rate.</p>					

(Added 2002) (Amended 2003)

Table 2. Tolerances for Vehicle-Mounted Milk Meters		
Indication	Maintenance	Acceptance
gallons	gallons	gallons
100	0.5	0.3
200	0.7	0.4
300	0.9	0.5
400	1.1	0.6
500	1.3	0.7
Over 500	Add 0.002 gallon per indicated gallon over 500	Add 0.001 gallon per Indicated gallon over 500

(Added 1989)

3.31. Vehicle-Tank Meters

T.3. Repeatability. - When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 percent absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance. See also N.4.1.2.

(Added 1992) (Amended 2001 and 2002)

UR. User Requirements

UR.1. Installation Requirements.

UR.1.1. Discharge Rate. - A meter shall be so installed that the actual maximum discharge rate will not exceed the rated maximum discharge rate. If necessary, means for flow regulation shall be incorporated in the installation, in which case this shall be fully effective and automatic in operation.

UR.1.2. Unit Price. - There shall be displayed on the face of a device of the computing type the unit price at which the device is set to compute.

UR.1.3. Intake Hose. - The intake hose in a milk-metering system shall be installed to permit complete drainage and ensure that all available product is measured following each pickup.

UR.1.4. Liquid Measured. - A vehicle-tank meter shall continue to be used to measure the same liquid or one with the same general physical properties as that used for calibration and weights and measures approval unless the meter is recalibrated with a different product and tested by a registered service agency or a weights and measures official and approved by the weights and measures jurisdiction having statutory authority over the device.
(Added 2003)

UR.2. Use Requirements.

UR.2.1. Return of Indicating and Recording Elements to Zero. - The primary indicating elements (visual), and the primary recording elements, when these are returnable to zero, shall be returned to zero immediately before each delivery is begun and after the pump has been activated and the product to be measured has been supplied to the measuring system.
(Amended 1981)

UR.2.2. Ticket Printer; Customer Ticket.

[NOT ADOPTED]

Section 4002.3. Vehicle-Tank Meters. (3.31.)

UR.2.2. Ticket Printer; Customer Ticket. Vehicle-mounted metering systems shall be equipped with a ticket printer which shall be used for all sales where product is delivered through the meter. A copy of the ticket issued by the device shall be left with the customer at the time of delivery or as otherwise specified by the customer.

[Nonretroactive as of January 1, 1995.]

UR.2.2.1. Exceptions for the Sale of Aviation Fuel. - The provisions of UR.2.2. Ticket Printer; Customer Ticket shall not apply to vehicle-mounted metering systems used solely for the sale of aviation fuel into aircraft and for aircraft-related operations.
(Added 1999)

UR.2.3. Ticket in Printing Device. - A ticket shall not be inserted into a device equipped with a ticket printer until immediately before a delivery is begun, and in no case shall a ticket be in the device when the vehicle is in motion while on a public street, highway, or thoroughfare.

UR.2.4. Credit for Flood Volume. - The volume of product necessary to flood the system as marked on the air eliminator shall be individually recorded on the pickup ticket of each seller affected.

S.4.2. Discharge Rates. - A device shall be marked to show its designed maximum and minimum discharge rates. The marked minimum discharge rate shall not exceed:

- (a) 20 L (5 gal) per minute for stationary retail devices, or
 - (b) 20% of the marked maximum discharge rate for other retail devices and for wholesale devices.
- (Amended 1987)

Note: See example in Section 3.30. Liquid-Measuring Devices Code, paragraph S.4.4.1.
(Added 2003)

S.4.3. Temperature Compensation. - If a device is equipped with an automatic temperature compensator, the primary indicating elements, recording elements, and recorded representation shall be clearly and conspicuously marked to show that the volume delivered has been adjusted to the volume at 15 °C (60 °F).

N. Notes

N.1. Test Liquid. - A device shall be tested with the liquid to be commercially measured or with a liquid of the same general physical characteristics.

N.2. Vaporization and Volume Change. - Care shall be exercised to reduce to a minimum, vaporization and volume changes.

N.3. Test Drafts. - Test drafts should be equal to at least the amount delivered by the device in 1 minute at its normal discharge rate.
(Amended 1982)

N.4. Testing Procedures.

N.4.1. Normal Tests. - The “normal” test of a device shall be made at the maximum discharge flow rate developed under the conditions of the installation. Any additional tests conducted at flow rates down to and including one-half the sum of the maximum discharge flow rate and the rated minimum discharge flow rate shall be considered normal tests.
(Amended 1998)

N.4.1.1. Automatic Temperature Compensation.

[NOT ADOPTED]

4002.4. Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices. (3.32.)

(c) Wholesale Devices Equipped With Automatic Temperature Compensating Systems. On wholesale devices equipped with automatic temperature compensating systems, normal tests:

- (1) Shall be conducted with the temperature compensating system connected and operating by comparing the compensated volume indicated or recorded to the actual delivered volume corrected to 60 °F; and
- (2) May be conducted with the temperature compensating system deactivated, comparing the uncompensated volume indicated or recorded to the actual delivered volume.

The first test shall be performed with the automatic temperature compensating system operating in the “as found” condition. On devices that indicate or record both the compensated and uncompensated volume for each delivery, the tests in (1) and (2) may be performed as a single test.

N.4.1.2. Repeatability Tests. - Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors such as, temperature pressure and flow rate are reduced to the extent that they will not affect the results obtained
(Added 2001)

N.4.2. Special Tests. - “Special” tests, to develop the operating characteristics of a device and any special elements and accessories attached to or associated with the device, shall be made as circumstances require. Any test except as set forth in N.4.1. shall be considered a special test.

N.4.2.1. For Motor-Fuel Devices. - A motor-fuel device shall be so tested at a minimum discharge rate of:

- (a) 20 L (5 gal) per minute, or
- (b) the minimum discharge rate marked on the device, whichever is less.

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N.4.2.2. For Other Retail Devices. - A retail device other than a motor-fuel device shall be tested at a minimum discharge rate of:

- (a) the minimum discharge rate that can be developed under the conditions of installation, or
 - (b) the minimum discharge rate marked on the device, whichever is greater.
- (Amended 1973)

N.4.2.3. For Wholesale Devices. - A wholesale device shall be so tested at a minimum discharge rate of:

- (a) 40 L (10 gal) per minute for a device with a rated maximum discharge less than 180 L (50 gal) per minute.
 - (b) 20 percent of the marked maximum discharge rate for a device with a rated maximum discharge of 180 L (50 gal) per minute or more, or
 - (c) the minimum discharge rate marked on the device, whichever is least.
- (Amended 1987)

N.4.3. Money-Value Computation Tests.

N.4.3.1. Laboratory Design Evaluation Tests. - In the conduct of laboratory design evaluation tests, compliance with paragraph S.1.5.2. shall be determined by using the cone gear as a reference for the total quantity delivered. The indicated delivered quantity shall agree with the cone gear representation with the index of the indicator within the width of the graduation. The maximum allowable variation of the indicated sales price shall be as shown in Table 1.

N.4.3.2. Field Tests. - In the conduct of field tests to determine compliance with paragraph S.1.5.2. the maximum allowable variation in the indicated sales price shall be as shown in Table 1.
(Added 1984)

N.5. Temperature Correction. - Corrections shall be made for any changes in volume resulting from the differences in liquid temperatures between time of passage through the meter and time of volumetric determination in the test measure.

T. Tolerances

T.1. Application.

T.1.1. To Underregistration and to Overregistration. The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration, whether or not a device is equipped with an automatic temperature compensator.

T.2. Tolerance Values. - The maintenance and acceptance tolerances for normal and special tests shall be as shown in Table T.2.
(Amended 1988, 1992 and 2003)

T.3. Repeatability. - When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 percent of the absolute value of the maintenance tolerance and the results of each test shall be within applicable tolerance. This tolerance does not apply to the test of the automatic temperature compensating system. See also N.4.1.2.
(Added 1992) (Amended 1997 and 2001)

**Table T.2. Accuracy Classes and Tolerance for
LPG and Anhydrous Ammonia Liquid-Measuring Devices**

Accuracy Class	Application	Acceptance Tolerance	Maintenance Tolerance	Special Test Tolerance
1.0	Anhydrous ammonia, LPG (including vehicled tank meters)	0.6%	1.0%	1.0%

(Added 2003)

T.4. Automatic Temperature Compensating Systems. - The difference between the meter error (expressed as a percentage) for results determined with and without the automatic temperature compensating system activated shall not exceed:

- (a) 1.0 percent for mechanical automatic temperature compensating systems; and
- (b) 0.5 percent for electronic automatic temperature compensating systems.

The delivered quantities for each test shall be approximately the same size. The results of each test shall be within the applicable acceptance or maintenance tolerance.

(Added 1991) (Amended 1992, 1996, and 1997)

UR. User Requirements

UR.1. Installation Requirements.

UR.1.1. Discharge Rate. - A device shall be so installed that the actual maximum discharge rate will not exceed the rated maximum discharge rate. If necessary, means for flow regulation shall be incorporated in the installation, in which case this shall be fully effective and automatic in operation.

UR.1.2. Length of Discharge Hose. - The length of the discharge hose on a stationary motor-fuel device shall not exceed 5.5 m (18 ft), measured from the outside of the housing of the device to the inlet end of the discharge nozzle, unless it can be demonstrated that a longer hose is essential to permit deliveries to be made to receiving vehicles or vessels. Unnecessarily remote location of a device shall not be accepted as justification for an abnormally long hose.

(Amended 1991)

UR.2. Use Requirements.

UR.2.1. Return of Indication and Recording Elements to Zero. - The primary indicating elements (visual), and the primary recording elements when these are returnable to zero, shall be returned to zero before each delivery.

UR.2.2. Condition of Fill of Discharge Hose. - The discharge hose shall be completely filled with liquid before the “zero” condition is established prior to the start of a commercial delivery, whether this condition is established by resetting the primary indicating elements to zero indication or by recording the indications of the primary indicating elements. (Also see UR.2.1.)

UR.2.3. Vapor-Return Line.

[NOT ADOPTED]

4002.4. Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices. (3.32.)

(d) Vapor-Return Line. During any metered delivery of liquefied petroleum gas from a supplier’s tank to a receiving container, there shall be no vapor-return line from the receiving container to the supplier’s tank.

UR.2.4. Temperature Compensation.

UR.2.4.1. Use of Automatic Temperature Compensators. - If a device is equipped with an automatic temperature compensator, this shall be connected, operable, and in use at all times. Such automatic temperature compensator may not be removed, nor may a compensated device be replaced with an uncompensated device, without the written approval of the weights and measures authority having jurisdiction over the device.

UR.2.4.2. Temperature Compensated Sale. - All sales of liquefied petroleum gas in a liquid state, when the quantity is determined by an approved measuring system equipped with a temperature compensating mechanism, or by weight and converted to liters or gallons, or by a calibrated container, shall be in terms of liters at 15 °C or the United States gallon of 231 in³ at 60 °F. (Added 1984)

UR.2.4.3. Invoices. - Any invoice based on a reading of a device that is equipped with an automatic temperature compensator or based on a weight converted to gallons, or based on the volume of a calibrated container, shall have shown thereon that the volume delivered has been adjusted to the volume at 15 °C (60 °F). (Amended 1984)

UR.2.4.4. Automated Temperature-Compensating Systems. - Means for determining the temperature of measured liquid in an automatic temperature-compensating system shall be so designed and located that, in any “usual and customary” use of the system, the resulting indications and/or recorded representations are within applicable tolerances. (Added 1987)

3.32. LPG and Anhydrous Ammonia Liquid-Measuring Devices

UR.2.5. Ticket in Printing Device. - A ticket shall not be inserted into a device equipped with a ticket printer until immediately before a delivery is begun, and in no case shall a ticket be in the device when the vehicle is in motion while on a public street, highway, or thoroughfare.

UR.2.6. Ticket Printer; Customer Ticket. - Vehicle-mounted metering systems shall be equipped with a ticket printer. The ticket printer shall be used for all sales; a copy of the ticket issued by the device shall be left with the customer at the time of delivery.

(Added 1992)

4002.4. Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices. (3.32.)

(e) Signs. Any retail liquefied petroleum gas dispenser, with the exception of those mounted on a motor vehicle, shall display a sign showing the price schedule of all transactions. The sign shall be where it is plainly discernable to the customer. All letters, figures or numerals used to express the price schedule shall be at least three-quarters of an inch in height.

S.4. Marking Requirements.

S.4.1. Limitations of Use. - If a device is intended to measure accurately only products having particular properties, or to measure accurately only under specific installation or operating conditions, or to measure accurately only when used in conjunction with specific accessory equipment, these limitations shall be clearly and permanently stated on the device.

S.4.2. Discharge Rates. - A volume-measuring device shall be marked to show its rated gas capacity in cubic meters per hour or cubic feet per hour.
(Amended 1973, 1991)

S.4.3. Temperature Compensation.
[NOT ADOPTED]

4002.5. Hydrocarbon Gas Vapor-Measuring Devices. (3.33.)

(b) Temperature Compensation. - If a device is equipped with an automatic temperature compensator, this shall be indicated on the badge or immediately adjacent to the badge of the device and on the register.

S.4.4. Badge. - A badge affixed in a prominent position on the front of the device shall show the manufacturer's name, serial number and model number of the device, and capacity rate of the device for the particular products that it was designed to meter as recommended by the manufacturer.

N. Notes

N.1. Test Medium. - The device shall be tested with air or the product to be measured.
(Amended 1991)

N.2. Temperature and Volume Change. - Care should be exercised to reduce to a minimum any volume changes. The temperature of the air, bell-prover oil, and the meters under test should be within 1 °C (2 °F) of one another. The devices should remain in the proving room for at least 16 hours before starting any proving operations to allow the device temperature to approximate the temperature of the proving device.

N.3. Test Drafts. - Except for low-flame tests, test drafts shall be at least equal to one complete revolution of the largest capacity proving indicator, and shall in no case be less than 0.05 m³ or 2 ft³. All flow rates shall be controlled by suitable outlet orifices.
(Amended 1973 and 1990)

N.4. Test Procedures. - If a device is equipped with an automatic temperature compensator, the proving device reading shall be corrected to 15 °C (60 °F), using an approved table.
(Amended 1972)

N.4.1. Normal Tests. - The normal test of a device shall be made at a rate not to exceed the capacity rate given on the badge of the meter.
(Amended 1988)

N.4.1.1. Automatic Temperature Compensation.
If a device is equipped with an automatic temperature compensator, the quantity of the test draft indication of the standard shall be corrected to 15 °C (60 °F).

N.4.1.2. Repeatability Tests. - Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors, such as temperature pressure, and flow rate are reduced to the extent that they will not affect the results obtained.
(Added 2002)

N.4.2. Special Tests. - "Special" tests, to develop the operating characteristics of a device, and any special elements and accessories attached to or associated with the device, shall be made as circumstances require. Any test except as set forth in N.4.1. is a special test.

N.4.2.1. Slow Test. - The device shall be tested at a rate not less than 20 percent of the marked capacity rate, or (at the check rate) not less than the minimum flow rate if marked on the device, whichever is less.
(Amended 1988)

N.4.2.2. Low-Flame Test. - The device shall be tested at an extremely low-flow rate as given in Table 1. The test shall consist of passing air at a pressure of 375 Pa (1.5 in water column) through the meter for not less than 60 minutes. The meter shall continue to advance at the conclusion of the test period.
(Amended 1990, 1991)

N.4.2.3. Pressure Regulation Test. - On devices operating at a pressure of 6 900 Pa (1 psig) or more, a pressure regulation test shall be made at both the minimum and maximum use load to determine the proper operation of the regulator and the proper sizing of the piping and dispensing equipment. These tests may include a test of 24 hours during which the pressure is recorded.
(Added 1984)

3.33. Hydrocarbon Gas Vapor-Measuring Devices

Table 1.
Capacity of Low-Flow Test Rate Orifices
With Respect to Device Capacity

Metric Units		Inch-Pound Units	
Rated Capacity	Low-Flow Test Rate	Rated Capacity	Low-Flow Test Rate
Up to and including 7 m ³ /h	0.007 m ³ /h	Up to and including 250 ft ³ /h	0.25 ft ³ /h
Over 7 m ³ /h up to and including 14 m ³ /h	0.014 m ³ /h	Over 250 ft ³ /h up to and including 500 ft ³ /h	0.50 ft ³ /h
Over 14 m ³ /h	0.1% of capacity rate	Over 500 ft ³ /h	0.1% of capacity rate

(Amended 1973)

N.5. Temperature Correction. - Corrections shall be made for any changes in volume resulting from the difference in air temperatures between time of passage through the device and time of volumetric determination in the proving device.

N.6. Frequency of Test. - A hydrocarbon gas vapor-measuring device shall be tested before installation and allowed to remain in service for 10 years from the time last tested without being retested, unless a test is requested by:

- (a) the purchaser of the product being metered,
- (b) the seller of the product being metered, or
- (c) the weights and measures official.

T. Tolerances

T.1. Tolerance Values on Normal Tests and on Special Tests Other Than Low-Flame Tests. - Maintenance and acceptance tolerances for normal and special tests for hydrocarbon gas vapor-measuring devices shall be as shown in Table T.1.

(Amended 1981 and 2003)

T.2. Repeatability – When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 0.9% and the results of each test shall be within the applicable tolerance. *See also N.4.1.2.*

(Added 2002)

UR. User Requirements

UR.1. Installation Requirements.

UR.1.1. Capacity Rate. - A device shall be so installed that the actual maximum flow rate will not exceed the capacity rate except for short durations. If necessary, means for flow regulation shall be incorporated in the installation, in which case this shall be fully effective and automatic in operation.

4002.5. Hydrocarbon Gas Vapor-Measuring Devices. (3.33.)

- (a) **Leak Test.** Each meter shall be submitted to a pressure leak test not to exceed the manufacturer's maximum rated pressure.

Table T.1. Accuracy Classes and Tolerances for Hydrocarbon Gas Vapor-Measuring Devices

Accuracy Class	Application		Acceptance Tolerance	Maintenance Tolerance
3.0	Gases at low pressure (for example, LPG vapor)	Overregistration	1.5%	1.5%
		Underregistration	3.0%	3.0%

(Added 2003)

3.33. Hydrocarbon Gas Vapor Measuring Devices

UR.1.2. Leakage. - The metering system shall be installed and maintained as a pressure-tight and leak-free system.

UR.2. Use Requirements.

UR.2.1. Automatic Temperature Compensation. - A compensated device may not be replaced with an uncompensated device without the written approval of the weights and measures authority having jurisdiction over the device.

UR.2.2. Invoices. - A customer purchasing hydrocarbon gas measured by a vapor meter for other than motor fuel shall receive from the seller an invoice for each billing period. The invoice shall clearly and separately show the following:

- (a) The opening and closing meter readings and the dates of those readings.
- (b) The altitude correction factor.
- (c) The total cubic meters (cubic feet) billed, corrected for elevation.
- (d) The charge per cubic meter (cubic foot) after correction for elevation.
- (e) All periodic charges independent of the measured gas, such as meter charges, meter reading fees, service charges or a minimum charge for a minimum number of cubic meters (cubic feet).
- (f) The total charge for the billing period.

If the vapor meter is equipped with an automatic temperature compensator, or any other means are used to compensate for temperature, the invoice shall show that the volume has been adjusted to the volume at 15 °C (60 °F).

(Amended 1988, 1991)

UR.2.3. Correction for Elevation. - The metered volume of gas shall be corrected for changes in the atmospheric pressure with respect to elevation to the standard pressure of 14.73 lb psia. The appropriate altitude correction factor from Table 2M or 2 shall be used. (The table is modified from NIST Handbook 117.) (Amended 1988)

Elevation correction factors (ACF) were obtained by using the following equation:

$$ACF = \frac{GP \text{ of gas} + AAP}{\text{base pressure}}$$

where

GP = gauge pressure

AAP = assumed atmospheric pressure

base pressure = 101.560 kPa = 14.73 psia

2740 Pa = 11 in of water column = 0.397 psig

1744 Pa = 7 in of water column = 0.253 psig
(Added 1988)

UR.2.4. Valves and Test Tee. - *All gas meter installations shall be provided with a shut-off valve located adjacent to and on the inlet side of the meter. In the case of a single meter installation utilizing a liquefied petroleum gas tank, the tank service valve may be used in lieu of the shut-off valve. All gas meter installations shall be provided with a test tee located adjacent to and on the outlet side of the meter.*

[Nonretroactive as of January 1, 1990.]

(Added 1989)

UR.2.5. Use of Auxiliary Heated Vaporizer Systems.

Automatic temperature compensation shall be used on hydrocarbon gas vapor meters equipped with an auxiliary heated vaporizer system unless there is sufficient length of underground piping to provide gas at a uniform temperature to the meter inlet. When required by weights and measures officials, a thermometer well (appropriately protected against freezing) shall be installed immediately up-stream of the meter.

(Added 1990)

4002.5. Hydrocarbon Gas Vapor-Measuring Devices. (3.33.)

(c) Retention of Customer Invoices. Any person engaging in the sale of hydrocarbon gas vapor shall retain a record of:

- (1) each individual hydrocarbon gas vapor meter billing invoice, and
- (2) the applicable rate schedule for a period of not less than 12 months and shall make them available at reasonable times for inspection and copying by the customer and the county sealer of weights and measures.

3.33. Hydrocarbon Gas Vapor-Measuring Devices

Table 2M. Corrections for Altitude, Metric Units							
Elevation (meters)			Altitude Correction Factor		Assumed Atmospheric Pressure	Assumed Atmospheric Pressure Plus Gauge Pressure	
			2.74 kPa Gauge Pressure	1.74 kPa Gauge Pressure	(kPa)	2.74 kPa Gauge Pressure	1.74 kPa Gauge Pressure
	-50 to	120	1.02	1.01	100.85	103.59	102.58
above	120 to	300	1.00	0.99	98.82	101.56	100.54
above	300 to	470	0.98	0.97	96.79	99.53	98.51
above	470 to	650	0.96	0.95	94.76	97.50	96.48
above	650 to	830	0.94	0.93	92.73	95.47	94.45
above	830 to	1020	0.92	0.91	90.70	93.44	92.42
above	1020 to	1210	0.90	0.89	88.66	91.40	90.39
above	1210 to	1400	0.88	0.87	86.63	89.37	88.36
above	1400 to	1590	0.86	0.85	84.60	87.34	86.33
above	1590 to	1790	0.84	0.83	82.57	85.31	84.29
above	1790 to	2000	0.82	0.81	80.54	83.28	82.26
above	2000 to	2210	0.80	0.79	78.51	81.25	80.23
above	2210 to	2420	0.78	0.77	76.48	79.22	78.20
above	2420 to	2640	0.76	0.75	74.45	77.19	76.17
above	2640 to	2860	0.74	0.73	72.41	75.15	74.15
above	2860 to	3080	0.72	0.71	70.38	73.12	72.12
above	3080 to	3320	0.70	0.69	68.35	71.09	70.08
above	3320 to	3560	0.68	0.67	66.32	69.06	68.05
above	3560 to	3800	0.66	0.65	64.29	67.03	66.01
above	3800 to	4050	0.64	0.63	62.26	65.00	63.98
above	4050 to	4310	0.62	0.61	60.23	62.97	61.95
above	4310 to	4580	0.60	0.59	58.20	60.94	59.92

(14.696 lb/in² absolute). *When a compensator system malfunctions, the indicating and recording elements may indicate and record in uncompensated volume if the mode of operation is clearly indicated, e.g., by a marked annunciator, recorded statement, or other obvious means.**

[*Nonretroactive as of January 1, 1992.]

(Amended 1991 and 2002)

S.2.5. Provision for Sealing. - Adequate provision shall be made for applying security seals in such a manner that no adjustment or interchange may be made of:

- (a) any measurement element,
- (b) any adjustable element for controlling delivery rate when such rate tends to affect the accuracy of deliveries, and
- (c) any automatic temperature or density compensating system.

Any adjusting mechanism shall be readily accessible for purposes of affixing a security seal.

S.3. Design of Discharge Lines and Discharge Line Valves.

S.3.1. Diversion of Measured Liquid. - No means shall be provided by which any measured liquid can be diverted from the measuring chamber of the device or the discharge line therefrom, except that a manually controlled outlet that may be opened for purging or draining the measuring system shall be permitted. Effective means shall be provided to prevent the passage of liquid through any such outlet during normal operation of the device and to indicate clearly and unmistakably when the valve controls are so set as to permit passage of liquid through such outlet.

S.3.2. Discharge Hose. - The discharge hose of a measuring system shall be of the completely draining dry-hose type.

S.4. Level Condition, On-Board Weighing Systems. - Provision shall be made for automatically inhibiting the delivery of a cryogenic liquid when the vehicle is out-of-level beyond the limit required for the performance to be within applicable tolerance.
(Added 1986)

S.5. Marking Requirements.

S.5.1. Limitation of Use. - If a measuring system is intended to measure accurately only liquids having particular properties, or to measure accurately only under specific installation or operating conditions, or to measure

accurately only when used in conjunction with specific accessory equipment, these limitations shall be clearly and permanently marked on the device.

S.5.2. Discharge Rates. - A meter shall be marked to show its designed maximum and minimum discharge rates.

S.5.3. Temperature or Density Compensation. - Devices equipped with an automatic temperature or density compensator, shall be clearly and conspicuously marked on the primary indicating elements, recording elements, and recorded representations to show that the quantity delivered has been adjusted to the conditions specified in S.2.4.

N. Notes

N.1. Test Liquid. - A meter shall be tested with the liquid to be commercially measured except that, in a type evaluation examination, nitrogen may be used.

N.2. Vaporization and Volume Change. - Care shall be exercised to reduce to a minimum vaporization and volume changes. When testing by weight, the weigh tank and transfer systems shall be precooled to liquid temperature prior to the start of the test to avoid the venting of vapor from the vessel being weighed.

N.3. Test Drafts.

N.3.1. Gravimetric Test. - Weight test drafts shall be equal to at least the amount delivered by the device in two minutes at its maximum discharge rate, and shall in no case be less than 907 kg (2 000 lb).

N.3.2. Transfer Standard Test. - When comparing a meter with a calibrated transfer standard, the test draft shall be equal to at least the amount delivered by the device in two minutes at its maximum discharge rate, and shall in no case be less than 180 L (50 gal) or equivalent thereof. When testing uncompensated volumetric meters in a continuous recycle mode, appropriate corrections shall be applied if product conditions are abnormally affected by this test mode.
(Amended 1976)

N.4. Density. - Temperature and pressure of the metered test liquid shall be measured during the test for the determination of density or volume correction factors when applicable. For Liquid Density and Volume Correction Factors (with respect to temperature and pressure) the following publication shall apply: "Thermophysical Properties of Fluids. 1. Argon, Ethylene, Parahydrogen, Nitrogen, Nitrogen Trifluoride, and Oxygen," published in the Journal of Physical and Chemical Reference Data, Volume 11, 1982, Supplement No. 1, and

3.34. Cryogenic Liquid-Measuring Devices

published by the American Chemical Society and the American Institute of Physics for the National Institute of Standards and Technology.
(Amended 1986)

N.5. Testing Procedures.

N.5.1. Normal Tests. - The “normal” tests of a device shall be made over a range of discharge rates that may be anticipated under the conditions of installation.

N.5.1.1. Repeatability Tests. - Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors, such as, temperature pressure and flow rate are reduced to the extent that they will not affect the results obtained.
(Added 2001)

N.5.2. Special Tests. - Any test except as set forth in N.5.1. shall be considered a “special” test. Tests shall be conducted, if possible, to evaluate any special elements or accessories attached to or associated with the device. A device shall be tested at a minimum discharge rate of:

- (a) 50 percent of the maximum discharge rate developed under the conditions of installation, or the minimum discharge rate marked on the device, whichever is less, or
- (b) the lowest discharge rate practicable under conditions of installation.

Special tests may be conducted to develop any characteristics of the device that are not normally anticipated under the conditions of installation as circumstances require.

N.6. Temperature Correction. - Corrections shall be made for any changes in volume resulting from the differences in liquid temperature between time of passage through the meter and time of volumetric determination of test draft.

N.7. Automatic Temperature or Density Compensation. When a device is equipped with an automatic temperature or density compensator, the compensator shall be tested by comparing the quantity indicated or recorded by the device (with the compensator connected and operating) with the actual delivered quantity corrected to the normal boiling point of the cryogenic product being measured or to the normal temperature and pressure as applicable.

T. Tolerances

T.1. Application.

T.1.1. To Underregistration and to Overregistration. The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration.

T.2. Tolerance Values. – The maintenance and acceptance tolerances for normal and special tests shall be as shown in Table T.2.
(Amended 2003)

T.3. On Tests Using Transfer Standards. - To the basic tolerance values that would otherwise be applied, there shall be added an amount equal to two times the standard deviation of the applicable transfer standard when compared to a basic reference standard.
(Added 1976)

Table T.2. Accuracy Classes and Tolerances for Cryogenic Liquid-Measuring Devices

Accuracy Class	Application	Acceptance Tolerance	Maintenance Tolerance	Special Test Tolerance
2.5	Cryogenic products; liquefied compressed gases other than liquid carbon dioxide	1.5%	2.5%	2.5%

(Added 2003)

T.4. Repeatability. - When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 percent of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance. See also N.5.1.1.

(Added 2001)

UR. User Requirements

UR.1. Installation Requirements.

UR.1.1. Discharge Rate. - A device shall be so installed that the actual maximum discharge rate will not exceed the rated maximum discharge rate. If necessary, means for flow regulation shall be incorporated in the installation.

UR.1.2. Length of Discharge Hose. - The discharge hose shall be of such a length and design as to keep vaporization of the liquid to a minimum.

UR.1.3. Maintenance of Liquid State. - A device shall be so installed and operated that the product being measured shall remain in the liquid state during passage through the meter.

UR.2. Use Requirements.

UR.2.1. Return of Indicating and Recording Elements to Zero. - The primary indicating elements (visual) and the primary recording elements shall be returned to zero immediately before each delivery.

UR.2.2. Condition of Discharge System. - The discharge system, up to the measuring element, shall be pre-cooled to liquid temperatures before a "zero" condition is established prior to the start of a commercial delivery.

UR.2.3. Vapor Return Line. - A vapor return line shall not be used during a metered delivery.
(Amended 1976)

UR.2.4. Drainage of Discharge Line. - On a dry-hose system, upon completion of a delivery, the vendor shall leave the discharge line connected to the receiving container with the valve adjacent to the meter in the closed position and the valve at the discharge line outlet in the open position for a period of at least:

- (a) 1 minute for small delivery devices, and
- (b) 3 minutes for large delivery devices,

to allow vaporization of some product in the discharge line to force the remainder of the product in the line to flow into the receiving container.

(Amended 1976)

UR.2.5. Conversion Factors. - Established conversion values (see references in N.4.) shall be used whenever metered liquids are to be billed in terms of:

- (a) kilograms or pounds based on a meter indication of liters, gallons, cubic meters of gas, or cubic feet of gas; or,
- (b) cubic meters or cubic feet of gas based on a meter indication of liters or gallons, kilograms, or pounds; or,
- (c) liters or gallons based on a meter indication of kilograms or pounds, cubic meters of gas or cubic feet of gas.

All sales of cryogenic liquids shall be based on either kilograms or pounds, liters or gallons at NBP¹, cubic meters of gas or cubic feet of gas at NTP¹.

(Amended 1986)

UR.2.6. Temperature or Density Compensation.

UR.2.6.1. Use of Automatic Temperature or Density Compensators. - If a device is equipped with an automatic temperature or density compensator, this shall be connected, operable, and in use at all times. Such automatic temperature or density compensator may not be removed, nor may a compensated device be replaced with an uncompensated device, without the written approval of the weights and measures authority having jurisdiction over the device.

UR.2.6.2. Tickets or Invoices. - Any written invoice or printed ticket based on a reading of a device that is equipped with an automatic temperature or density compensator shall have shown thereon that the quantity delivered has been adjusted to the quantity at the NBP of the specific cryogenic product or the equivalent volume of gas at NTP.

¹ See Definitions section.

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UR.2.6.3. Printed Ticket. - Any printed ticket issued by a device of the computing type on which there is printed the total computed price, the total quantity of the delivery, or the price per unit, shall also show the other two values (either printed or in clear script).

UR.2.6.4. Ticket in Printing Device. - A ticket shall not be inserted into a device equipped with a ticket printer until immediately before a delivery is begun, and in no case shall a ticket be in the device when the vehicle is in motion while on a public street, highway, or thoroughfare.

UR.2.7. Pressure of Tanks with Volumetric Metering Systems Without Temperature Compensation. - When the saturation pressure of the product in the vendor's tank exceeds 240 kPa (35 psia), a correction shall be applied to the written invoice or printed ticket using the appropriate tables as listed in N.4.; or the saturation pressure shall be reduced to 207 kPa (30 psia) (if this can be safely accomplished) prior to making a delivery.
(Added 1976)

from the supply tank to the receiving tank without being measured by the device. A manually controlled outlet that may be opened for purging or draining the measuring system shall be permitted. Effective means shall be provided to prevent passage of liquid through any such outlet during normal operation of the measuring system. (Amended 1994)

S.3.2. Intake Hose. - The intake hose shall be:

- (a) of the dry-hose type,
- (b) adequately reinforced,
- (c) not more than 6 m (20 ft) in length unless it can be demonstrated that a longer hose is essential to permit transfer from a supply tank; and
- (d) connected to the pump at horizontal or above to permit complete drainage of the hose. (Amended 1991)

S.4. Marking Requirements.

S.4.1. Limitation of Use. - If a meter is intended to measure accurately only liquids having particular properties, or to measure accurately only under specific installation or operating conditions, or to measure accurately only when used in conjunction with specific accessory equipment, these limitations shall be clearly and permanently stated on the meter.

S.4.2. Discharge Rates. - A meter shall be marked to show its designed maximum and minimum discharge rates. The marked minimum discharge rate shall not exceed 20% of the marked maximum discharge rate. (Amended 2003)

Note: See Example in Section 3.30. Liquid-Measuring Devices Code, paragraph S.4.4.1. (Added 2003)

S.4.3. Measuring Components. - All components that affect the measurement of milk that are disassembled for cleaning purposes shall be clearly and permanently identified with a common serial number.

S.4.4. Flood Volume. - When applicable, the volume of product (to the nearest minimum division of the meter) necessary to flood the system when dry shall be clearly, conspicuously, and permanently marked on the air eliminator.

S.4.5. Conversion Factor. - When the conversion factor of 1.03 kg/L (8.6 lb/gal) is used to convert the volume of milk to weight, the conversion factor shall be clearly marked on the primary indicating element and recorded on the delivery ticket.

N. Notes

N.1. Test Liquid.

- (a) A meter shall be tested with the liquid to be commercially measured or with a liquid of the same general physical characteristics. Following a satisfactory examination, the weights and measures official should attach a seal or tag indicating the product used during the test. (Amended 1989)
- (b) A milk measuring system shall be tested with the type of milk to be measured when the accuracy of the system is affected by the characteristics of milk (e.g., positive displacement meters). (Added 1989)

N.2. Evaporation and Volume Change. - Care shall be exercised to reduce to a minimum, evaporation losses and volume changes resulting from changes in temperature of the test liquid.

N.2.1. Temperature Correction. - Corrections shall be made for any changes in volume resulting from the differences in liquid temperatures between time of passage through the meter and time of volumetric determination in the test measure. When adjustments are necessary, appropriate tables should be used.

N.3. Test Drafts. - Test drafts should be equal to at least the amount delivered by the device in one minute at its maximum discharge rate, and shall in no case be less than 400 L or 400 kg (100 gal or 1 000 lb). (Amended 1989)

N.4. Testing Procedures.

N.4.1. Normal Tests. - The “normal” test of a meter shall be made at the maximum discharge rate that may be anticipated under the conditions of the installation. The “normal” test shall include a determination of the effectiveness of the air elimination system.

N.4.1.1. Repeatability Tests. - Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors, such as temperature, pressure, and flow rate are reduced to the extent that they will not affect the results obtained. (Added 2002)

3.35. Milk Meters

N.4.2. Special Tests. - “Special” tests to develop the operating characteristics of a meter and any special elements and accessories attached to or associated with the meter, shall be made as circumstances require. Any test except as set forth in N.4.1. shall be considered a special test.

N.4.3. System Capacity. - The test of a milk-metering system shall include the verification of the volume of product necessary to flood the system as marked on the air eliminator.

T. Tolerances

T.1. Application.

T.1.1. To Underregistration and to Overregistration. The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration.

T.2. Tolerance Values. - Maintenance and acceptance tolerances shall be as shown in Table 1.
(Amended 1989)

Table 1. Tolerances		
Milk Meters		
Indication	Maintenance	Acceptance
gallons	gallons	gallons
100	0.5	0.3
200	0.7	0.4
300	0.9	0.5
400	1.1	0.6
500	1.3	0.7
Over 500	Add 0.002 gallon per indicated gallon over 500	Add 0.001 gallon per indicated gallon over 500

*Added 1989

T.3. Repeatability – When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 percent of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance. See also N.4.1.1.
(Added 2002)

UR. User Requirements

UR.1. Installation Requirements.

UR.1.1. Plumb and Level Condition. - A device installed in a fixed location shall be installed plumb and level, and the installation shall be sufficiently strong and rigid to maintain this condition.

UR.1.2. Discharge Rate. - A meter shall be so installed that the actual maximum discharge rate will not exceed the rated maximum discharge rate. If necessary, means for flow regulation shall be incorporated in the installation, in which case this shall be fully effective and automatic in operation.

UR.1.3. Unit Price. - There shall be displayed on the face of a device of the computing type the unit price at which the device is set to compute.

UR.1.4. Intake Hose. - The intake hose shall be so installed as to permit complete drainage and that all available product is measured following each transfer.

UR.2. Use Requirements.

UR.2.1. Return of Indicating and Recording Elements to Zero. - The primary indicating elements (visual), and the primary recording elements when these are returnable to zero, shall be returned to zero before each transfer.

UR.2.2. Printed Ticket. - Any printed ticket issued by a device of the computing type on which there is printed the total computed price, the total quantity, or the price per unit of quantity, shall also show the other two values (either printed or in clear script).
(Amended 1989)

UR.2.3. Ticket in Printing Device. - A ticket shall not be inserted into a device equipped with a ticket printer until immediately before a transfer is begun. If the meter is mounted on a vehicle, in no case shall a ticket be in the device when the vehicle is in motion while on a public street, highway, or thoroughfare.

UR.2.4. Credit for Flood Volume. - The volume of product necessary to flood the system as marked on the air eliminator shall be individually recorded on the ticket of each transfer affected.

Sec. 3.36. Water Meters

A. Application

A.1. This code applies to devices used for the measurement of water; generally applicable to, but not limited to, utilities type meters installed in residences or business establishments and meters installed in batching systems.
(Amended 2002)

A.2. This code does not apply to:

- (a) water meters mounted on vehicle tanks (for which see Sec. 3.31. Code for Vehicle Tank Meters).
- (b) mass flow meters (see Sec. 3.37. Code for Mass Flow Meters).
(Added 1994)

A.3. See also Sec. 1.10; General Code requirements.

S. Specifications

S.1. Design of Indicating and Recording Elements and of Recorded Representations.

S.1.1. Primary Elements.

S.1.1.1. General. A water meter shall be equipped with a primary indicating element and may also be equipped with a primary recording element. Such elements shall be visible at the point of measurement or be stored in non-volatile and nonresettable memory. The display may be remotely located provided it is readily accessible to the customer.
(Amended 2002)

S.1.1.2. Units. A water meter shall indicate and record, if the device is equipped to record, its deliveries in terms of liters, gallons or cubic feet or binary or decimal subdivisions thereof except batch plant meters, which shall indicate deliveries in terms of liters, gallons or decimal subdivisions of the liter or gallon only.

S.1.1.3. Value of Smallest Unit. The value of the smallest unit of indicated delivery and recorded delivery, if the device is equipped to record, shall not exceed the equivalent of:

- (a) 50 L (10 gal) on utility type meters,
- (b) 0.2 L (1/10 gal) on batching meters delivering less than 375 L/min (100 gal/min), or

- (c) 5 L (1 gal) on batching meters delivering 375 L/min (100 gal/min) or more.

S.1.1.4. Advancement of Indicating and Recording Elements. Primary indicating and recording elements shall be susceptible to advancement only by the mechanical operation of the device.

S.1.1.5. Return to Zero. If the meter is so designed that the primary indicating elements are readily returnable to a definite zero indication, means shall be provided to prevent the return of these elements beyond their correct zero position.

S.1.2. Graduations.

S.1.2.1. Length. Graduations shall be so varied in length that they may be conveniently read.

S.1.2.2. Width. In any series of graduations, the width of a graduation shall in no case be greater than the width of the minimum clear interval between graduations, and the width of main graduations shall be not more than 50 percent greater than the width of subordinate graduations. Graduations shall in no case be less than 0.2 mm (0.008 in) in width.

S.1.2.3. Clear Interval Between Graduations. The clear interval shall not be less than 1.0 mm (0.04 in). If the graduations are not parallel, the measurement shall be made:

- (a) along the line of relative movement between the graduations at the end of the indicator, or
- (b) if the indicator is continuous, at the point of widest separation of the graduations.

S.1.3. Indicators.

S.1.3.1. Symmetry. The index of an indicator shall be symmetrical with respect to the graduations, at least throughout that portion of its length associated with the graduations.

S.1.3.2. Length. The index of an indicator shall reach to the finest graduations with which it is used, unless the indicator and the graduations are in the same plane, in which case the distance between the end of the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 1.0 mm (0.04 in).

3.36. Water Meters

S.1.3.3. Width. The width of the index of an indicator in relation to the series of graduations with which it is used shall not be greater than:

- (a) *the width of the narrowest graduation**, and
[*Nonretroactive as of January 1, 2002]
(Amended 2001)
- (b) the width of the minimum clear interval between graduations.

When the index of an indicator extends along the entire length of a graduation, that portion of the index of the indicator that may be brought into coincidence with the graduation shall be of the same width throughout the length of the index that coincides with the graduation.

S.1.3.4. Clearance. The clearance between the index of an indicator and the graduations shall in no case be more than 1.5 mm (0.06 in).

S.1.3.5. Parallax. Parallax effects shall be reduced to the practicable minimum.

S.2. Design of Measuring Elements.

S.2.1. Provision for Sealing. - Adequate provision shall be made for applying security seals in such a manner that no adjustment may be made of:

- (a) any measurement elements, and
- (b) any adjustable element for controlling delivery rate when such rate tends to affect the accuracy of deliveries.

The adjusting mechanism shall be readily accessible for purposes of affixing a security seal.

S.2.2. Batching Meters Only.

S.2.2.1. Air Elimination. Batching meters shall be equipped with an effective air eliminator.

S.2.2.2. Directional Flow Valves. Valves intended to prevent reversal of flow shall be automatic in operation.

S.2.3. Multi-Jet Meter Identification. Multi-jet water meters shall be clearly and permanently marked as such on the device or identified on the Certificate of Conformance.
(Added 2003)

N. Notes

N.1. Test Liquid. A meter shall be tested with water.

N.2. Evaporation and Volume Change. Care shall be exercised to reduce to a minimum, evaporation losses and volume changes resulting from changes to temperature of the test liquid.

N.3. Test Drafts. - Test drafts should be equal to at least the amount delivered by the device in 2 minutes and in no case less than the amount delivered by the device in 1 minute at the actual maximum flow rate developed by the installation. The test draft sizes shown in Table N.4.1., shall be followed as closely as possible.
(Amended 2003)

N.4. Testing Procedures.

N.4.1. Normal Tests. The normal test of a meter shall be made at the maximum discharge rate developed by the installation. Meters with maximum gallon per minute ratings higher than the values specified in Table N.4.1. may be tested up to the meter rating, with meter indications no less than those shown.
(Amended 1990, 2002 and 2003)

Table N.4.1. Flow Rate and Draft Size for Water Meters			
Normal Tests			
Meter Size (inches)	Rate of Flow (gal/min)	Maximum Rate	
		Meter Indication/Test Draft	
		gal	ft ³
Less than 5/8	8	50	5
5/8	15	50	5
3/4	25	50	5
1	40	100	10
1 1/2	80	300	40
2	120	500	40
3	250	500	50
4	350	1 000	100
6	700	1 000	100

(Table Added 2003)

N.4.1.1. Repeatability Tests. – Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors, such as temperature, pressure, and flow rate are reduced to the extent that they will not affect the results obtained.
(Added 2002)

N.4.2. Special Tests. Special tests to develop the operating characteristics of meters may be made according to the rates and quantities shown in Table N.4.2.
(Amended 2003)

N.4.3. Batching Meter Tests. Tests on batching meters should be conducted at the maximum and intermediate rates only.

**Table N.4.2. Flow Rate and Draft Size for Water Meters
Special Tests**

Meter Size (inches)	Intermediate Rate			Minimum Rate		
	Rate of Flow (gal/min)	Meter Indication/Test Draft		Rate of flow (gal/min)	Meter Indication/Test Draft	
		gal	ft ³		gal	ft ³
Less than or equal to 5/8	2	10	1	1/4	5	1
3/4	3	10	1	1/2	5	1
1	4	10	1	3/4	5	1
1 1/2	8	50	5	1 1/2	10	1
2	15	50	5	2	10	1
3	20	50	5	4	10	1
4	40	100	10	7	50	5
6	60	100	10	12	50	5

(Table Added 2003)

3.36. Water Meters

Table T.1. Accuracy Classes and Tolerances for Water Meters

Accuracy Class	Application		Acceptance Tolerance	Maintenance Tolerance	Tolerance for Special Tests Conducted at the Minimum Flow Rate
1.5	Water, Other than Multi-Jet Water Meters	Overregistration	1.5%	1.5%	1.5%
		Underregistration	1.5%	1.5%	5.0%
1.5	Water, Multi-Jet Water Meters	Overregistration	1.5%	1.5%	3.0%
		Underregistration	1.5%	1.5%	3.0%

(Table Added 2003)

T. Tolerances

T.1. Tolerance Values. Maintenance and acceptance tolerances shall be as shown in Table T.1.
(Amended 2003)

T.1.1. Repeatability. When multiple tests are conducted at approximately the same flow rate, the range of the test results shall not exceed 0.6 percent for tests performed at the normal and intermediate flow rates, and 1.3 percent for tests performed at the minimum flow rate, and each test shall be within the applicable tolerance.
(Added 2002)

UR.1.2. Siphon Breaker. An automatic siphon breaker or other effective means shall be installed in the discharge piping at the highest point of outlet, in no case below the top of the meter, to prevent siphoning of the meter and permit rapid drainage of the pipe or hose.

UR.1.3. Provision for Testing. Acceptable provisions for testing shall be incorporated into all meter systems. Such provisions shall include a two-way valve, or manifold valving, and a pipe or hose installed in the discharge line accessible to the proper positioning of the test measure.

UR. User Requirements

UR.1. Batching Meters Only.

UR.1.1. Strainer. A filter or strainer shall be provided if it is determined that the water contains excessive amounts of foreign material.

Sec. 5.56.(a) Grain Moisture Meters

Section 5.56. has been reorganized into two sections. This Section, 5.56.(a), is applicable to all NTEP grain moisture meters. It is also applicable to any grain moisture meter manufactured or placed into service after January 1, 1998. (Code reorganized and renumbered 1996.)

A. Application

A.1. This code applies to grain moisture meters; that is, devices used to indicate directly the moisture content of cereal grain and oil seeds. The code consists of general requirements applicable to all moisture meters and specific requirements applicable only to certain types of moisture meters. Requirements cited for “test weight per bushel” indications or recorded representations are applicable only to devices incorporating an automatic test weight per bushel measuring feature.

(Amended 2003)

A.2. This code does not apply to devices used for in-motion measurement of grain moisture content or seed moisture content.

A.3. Type Evaluation - The National Type Evaluation Program will accept for type evaluation only those devices that comply with this code. State enforcement will be based upon the effective dates identified with each requirement when specific dates are shown.

(Added 1993)

A.4. See also Sec. 1.10; General Code requirements.

S. Specifications

S.1. Design of Indicating, Recording, and Measuring Elements.

S.1.1. Digital Indications and Recording Elements.

- (a) Meters shall be equipped with a digital indicating element.
- (b) The minimum height for the digits used to display moisture content shall be 10 mm.
- (c) Meters shall be equipped with a communication interface that permits interfacing with a recording element and transmitting the date, grain type, grain moisture results, test weight per volume results, and calibration version identification.

(d) A digital indicating element shall not display, and a recording element shall not record, any moisture content values or test weight per volume values before the end of the measurement cycle.

(e) Moisture content results shall be displayed and recorded as percent moisture content, wet basis. Test weight per bushel results shall be displayed and recorded as pounds per bushel. Subdivisions of these units shall be in terms of decimal subdivisions (not fractions).

(f) A meter shall not display or record any moisture content or test weight per volume values when the moisture content of the grain sample is beyond the operating range of the device, unless the moisture and test weight representations include a clear error indication (and recorded error message with the recorded representation).

(g) On multi-constituent meters (e.g., meters which also measure grain protein), provision shall be made for displaying and recording the constituent label (such as moisture, protein, etc.) to make it clear which constituent is associated with each of the displayed and recorded values.

(Added 1995)

(Added 1993) (Amended 1994, 1995 and 2003)

S.1.2. Grain or Seed Kind and Class Selection and Recording.

- Provision shall be made for selecting and recording the kind and class (as appropriate) of grain or seed to be measured. The means to select the kind and class of grain or seed shall be readily visible and the kind and class of grain or seed selected shall be clearly and definitely identified. Abbreviations for grain types indicated on the meter must meet the minimum acceptable abbreviations listed in Table S.1.2. Meters shall have the capability (i.e., display capacity) of indicating the grain type using a minimum of four characters in order to accommodate the four-character abbreviations listed in Table S.1.2.

(Amended 1993, 1995, and 1997)

5.56.(a) Grain Moisture Meters

S.1.3. Operating Range. - A meter shall automatically and clearly indicate when the operating range of the meter has been exceeded. The operating range shall specify the following:

(a) Temperature Range of the Meter

The temperature range over which the meter may be used and still comply with the applicable requirements shall be specified. The minimum temperature range shall be 10 °C to 30 °C. No moisture value may be displayed when the temperature range is exceeded. An appropriate message shall be displayed when the temperature of the meter is outside its specified operating range.

(b) Temperature Range of Each Grain or Seed

The temperature range for each grain or seed for which the meter is to be used shall be specified. The minimum temperature range for each grain shall be 0 °C to 40 °C. No moisture value may be displayed when the temperature range is exceeded. An appropriate error message shall be displayed when the temperature of the grain sample exceeds the specified temperature range for the grain.

(c) Moisture Range of the Grain or Seed

The moisture range for each grain or seed for which the meter is to be used shall be specified. Moisture and test weight per bushel values may be displayed when the moisture range is exceeded if accompanied by a clear indication that the moisture range has been exceeded.

(Amended 2003)

(d) Maximum Allowable Meter/Grain Temperature Difference

The maximum allowable difference in temperature between the meter and the sample for which an accurate moisture determination can be made shall be specified. The minimum temperature difference shall be 10 °C. No moisture value may be displayed when the maximum allowable temperature difference is exceeded. An appropriate error message shall be displayed when the difference in temperature between the meter and the sample exceeds the specified difference.

(Added 1993) (Amended 1995)

S.1.4. Value of Smallest Unit. - The display shall permit moisture value determination to both 0.01% and 0.1% resolution. The 0.1% resolution is for commercial transactions; the 0.01% resolution is for type evaluation and calibration purposes only, not for commercial purposes. Test weight per bushel values shall be determined to the nearest 0.1 pound per bushel.

(Amended 2003)

S.1.5. Operating Temperature.

(a) Warm up period: When a meter is turned on it shall not display or record any usable values until the operating temperature necessary for accurate determination has been attained, or the meter shall bear a conspicuous statement adjacent to the indication stating that the meter shall be turned on for a time period specified by the manufacturer prior to use.

(b) A meter shall meet the requirements of T.2. – Tolerance values when operated in the temperature range of 10 °C to 30 °C (50 °F to 86 °F) or within the range specified by the meter manufacturer.

(c) If the manufacturer specifies a temperature range, the range shall be at least 20 °C (36 °F).

(Added 1993) (Amended 1995 and 1996)

S.2. Design of Grain Moisture Meters

S.2.1. Minimum Sample Size. - Meters shall be designed to measure the moisture content of representative-size grain samples. The minimum allowable sample size used in analysis shall be 100 g or 400 kernels or seeds, whichever is smaller.

(Added 1993) (Amended 1995)

S.2.2. Electric Power Supply.

S.2.2.1. Power Supply, Voltage and Frequency.

(a) A meter that operates using alternating current must perform within the tolerances defined in Section T.2. Tolerance Values over the line voltage range 100 V to 130 V, or 200 V to 250 V rms as designed, and over the frequency range of 59.5 Hz to 60.5 Hz.

(b) Battery-operated instruments shall not indicate or record values outside the applicable tolerance limits when battery power output is excessive or deficient.

S.2.2.2. Power Interruption. - A power interruption shall not cause an indicating or recording element to display or record any values outside the applicable tolerance limits.
(Added 1988)

S.2.3 Level-Indicating Means. - A meter shall be equipped with a level indicator and leveling adjustments if its performance is changed by an amount greater than the applicable tolerance when the meter is moved from a level position to a position that is out of level in any upright direction by up to 5 percent (approximately 3 degrees).

The level-indicating means shall be readable without removing any meter parts requiring a tool.
(Added 1988) (Amended 1994)

S.2.4. Calibration Integrity.

S.2.4.1. Calibration Version. - A meter must be capable of displaying either calibration constants, a unique calibration name, or a unique calibration version number for use in verifying that the latest version of the calibration is being used to make moisture content and test weight per bushel determinations.
(Added 1993) (Amended 1995 and 2003)

S.2.4.2. Calibration Corruption. - If calibration constants are digitally stored in an electronically alterable form, the meter shall be designed to make automatic checks to detect corruption of calibration constants. An error message must be displayed if calibration constants have been electronically altered.
(Added 1993) (Amended 1995)

S.2.4.3. Calibration Transfer. - *The instrument hardware/software design and calibration procedures shall permit calibration development and the transfer of calibrations between instruments of like models without requiring user slope or bias adjustments.*

[Note: Only the manufacturer or the manufacturer's designated service agency may make standardization adjustments on moisture meters. This does not preclude the possibility of the operator installing manufacturer-specified calibration constants under the instructions of the manufacturer or its designated service agency.] Standardization adjustments (not to be confused with grain calibrations) are those physical adjustments or software parameters which make meters of like type respond identically to the grain(s) being measured.
[Nonretroactive as of January 1, 1999.]
(Added 1994) (Amended 1998)

S.2.5. Provision for Sealing. - Provision shall be made for applying a security seal in a manner that requires the security seal to be broken, or for using other approved means of providing security (e.g., audit trail available at the time of inspection as defined in Table S.2.5.*) before any change that affects the metrological integrity of the device can be made to any mechanism.

[*Note: Table S.2.5. is Nonretroactive as of January 1, 1999.]

[Note: Zero-setting and test point adjustments are considered to affect metrological characteristics and must be sealed.]
(Added 1993) (Amended 1995 and 1997)

S.2.6. Determination of Quantity and Temperature. -

The moisture meter system shall not require the operator to judge the precise volume or weight and temperature needed to make an accurate moisture determination. External grinding, weighing, and temperature measurement operations are not permitted. In addition, if the meter is capable of measuring test weight per bushel, determination of sample volume and weight for this measurement shall be fully automatic *and means shall be provided to ensure that measurements of test weight per bushel are not allowed to be displayed or printed when an insufficient sample volume is available to provide an accurate measurement.*

[Nonretroactive as of January 1, 2004]

(Added 1994) (Amended 1995 and 2003)

S.3. Accessory Equipment - When the operating instructions for a moisture meter require accessory equipment separate from and external to the moisture meter, such equipment shall be appropriate and complete for the measurement.

S.4. Operating Instructions and Use Limitations. - The manufacturer shall furnish operating instructions for the device and accessories that include complete information concerning the accuracy, sensitivity, and use of accessory equipment necessary in obtaining a moisture content. Operating instructions shall include the following information:

- (a) name and address or trademark of the manufacturer;
- (b) the type or design of the device with which it is intended to be used;
- (c) date of issue;
- (d) the kinds or classes of grain or seed for which the device is designed to measure moisture content and test weight per bushel;
(Amended 2003)

5.56.(a) Grain Moisture Meters

- (e) the limitations of use, including but not confined to the moisture measurement range, grain or seed temperature, maximum allowable temperature difference between grain sample and meter, kind or class of grain or seed, moisture meter temperature, voltage and frequency ranges, electromagnetic interferences, and necessary accessory equipment.

(Added 1984)

N. Notes

N.1. Testing Procedures. Field evaluation of grain moisture meters shall be performed by one of the following methods:

N.1.1. Air Oven Reference Method Transfer Standards.

Official grain samples shall be used as the official transfer standards with moisture content and test weight per bushel values assigned by the reference methods. The reference methods for moisture shall be the oven drying methods as specified by the USDA GIPSA. The test weight per bushel value assigned to a test weight transfer standard shall be the average of 10 test weight per bushel determinations using the quart kettle test weight per bushel apparatus as specified by the USDA GIPSA. Tolerances shall be applied to the average of at least three measurements on each official grain sample. Official grain samples shall be clean and naturally moist, but not tempered (i.e., water not added).

(Amended 1992, 2001 and 2003)

N.1.2. Minimum Test. - A minimum test of a grain moisture meter shall consist of tests using samples (need not exceed three) of each grain or seed type for which the device is used, and for each grain or seed type shall include the following:

- (a) tests of moisture indications, using samples having at least two different moisture content values within the operating range of the device; and
- (b) if applicable, tests of test weight per bushel indications, with at least the lowest moisture samples used in (a) above.

(Amended 1986, 1989 and 2003)

N.1.3. Meter to Like-Type Meter Method Transfer Standards. - Properly standardized reference meters using National Type Evaluation Program approved calibrations shall be used as transfer standards. A reference meter shall be of the same type as the meter under test. Tests shall be conducted side-by-side using, as a comparison medium, grain samples that are clean and naturally moist, but not tempered (i.e., water not added).

(Added 2001)

T. Tolerances

T.1. To Underregistration and to Overregistration. - The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration.

T.2. Air Oven Reference Method. - Maintenance and acceptance tolerances shall be as shown in Table T.2.1. Tolerances are expressed as a fraction of the percent moisture content of the official grain sample, together with a minimum tolerance.

(Amended 2001)

**Table T.2.1. Acceptance and Maintenance Tolerances
Air Oven Reference Method**

Type of Grain or Seed	Tolerance	Minimum Tolerance
Corn, oats, rice, Sorghum, sunflower	0.05 of the percent moisture content	0.8 percent in moisture content
All other cereal grains and oil seeds	0.04 of the percent moisture content	0.7 percent in moisture content

(Amended 2001)

T.2.2. Meter to Like-Type Meter Method. - Maintenance and acceptance tolerances shall be as shown in Table T.2.2. The tolerances shall apply to all types of grain and seed.

(Added 2001)

**Table T.2.2. Acceptance and Maintenance Tolerances
Meter to Like Type Meter Method**

Sample Reference Moisture	Tolerance
Up to 22 percent	0.5 percent in moisture content

(Table Added 2001)

T.3. For Test Weight Per Bushel Indications or Recorded Representations. - The maintenance and acceptance tolerances on test weight per bushel indications or recorded representations shall be as shown in Table T.3. Tolerances are (+) positive or (-) negative with respect to the value assigned to the official grain sample.

(Amended 1992 and 2003)

Table T.3. Acceptance and Maintenance Tolerances Test Weight Per Bushel	
Type of Grain or Seed	Tolerance (Pounds Per Bushel)
Corn, oats	0.8
All wheat classes	0.5
Soybeans, barley, rice, sunflower, sorghum	0.7

(Added 2003)

UR. User Requirements

UR.1. Selection Requirements.

UR.1.1. Value of the Smallest Unit on Primary Indicating and Recording Elements. - The resolution of the moisture meter display shall be 0.1% moisture and 0.1 pound per bushel test weight during commercial use.

(Amended 2003)

UR.1.2. See G-UR.1.2.

UR.2. Installation Requirements. - The grain moisture meter shall be installed in an environment within the range of temperature and/or other environmental factors specified in the operating instructions.

UR.3. Use Requirements.

UR.3.1. Operating Instructions. - The operating instructions for the use of the grain moisture meter shall be readily available to the user, service technician, and weights and measures official at the place of installation. It shall include a list of accessory equipment and the kinds of grain or seed to be measured with the moisture meter.

(Amended 1988)

UR.3.2. Other Devices Not Used for Commercial Measurement. - If there are other moisture meters on the premises not used for trade or determining other charges for services, these devices shall be clearly and conspicuously marked "Not for Use in Trade or Commerce."

UR.3.3. Maintaining Integrity of Grain Samples. - Whenever there is a time lapse (temperature change) between taking the sample and testing the sample, means to prevent condensation of moisture or loss of moisture from grain samples shall be used. For example, a cold grain sample may be kept in a closed container in order to permit the cold grain to come to the operating temperature range of the meter before the grain moisture measurements are made.

UR.3.4. Printed Tickets.

- (a) Printed tickets shall be free from any previous indication of moisture content or type of grain or seed selected.
- (b) The customer shall be given a printed ticket showing the date, grain type, grain moisture results, test weight per bushel, and calibration version identification. The ticket shall be generated by the grain moisture meter system.

(Amended 1993, 1995 and 2003)

UR.3.5. Accessory Devices. - Accessory devices, if necessary in the determination of a moisture content value, shall be in close proximity to the moisture meter and allow immediate use.

UR.3.6. Sampling. - A grain sample shall be obtained by following appropriate sampling methods and equipment. These include, but are not limited to grain probes of appropriate length used at random locations in the bulk, the use of a pelican sampler, or other techniques and equipment giving equivalent results. The grain sample shall be taken such that it is representative of the lot.

UR.3.7. Location. - See G-UR.3.3.

UR.3.8. Level Condition. - If equipped with a level indicator, a meter shall be maintained in a level condition.
(Added 1988)

UR.3.9. Current Calibration Data. - Grain moisture determinations shall be made using only the most recently published calibration data.

UR.3.10. Posting of Meter Operating Range. - The operating range of the grain moisture meter shall be clearly and conspicuously posted in the place of business such that the information is readily visible from a reasonable customer position. The posted information shall include the following:

5.56.(a) Grain Moisture Meters

- (a) The temperature range over which the meter may be used and still comply with the applicable requirements. If the temperature range varies for different grains or seed, the range shall be specified for each.
- (b) The moisture range for each grain or seed for which the meter is to be used.
- (c) The temperature range for each grain or seed for which the meter is to be used.
- (d) The maximum allowable difference in temperature that may exist between the meter and the sample for which an accurate moisture determination can be made.
(Added 1988)

Table S.1.2. Grain Types Considered for Type Evaluation and Calibration and Minimum Acceptable Abbreviations			
Grain Type	Minimum Acceptable Abbreviation	Grain Type	Minimum Acceptable Abbreviation
<i>Corn</i>	<i>CORN</i>	<i>Soybeans</i>	<i>SOYB</i>
<i>Durum Wheat</i> <i>Soft White Wheat</i> <i>Hard Red Spring Wheat</i> <i>Hard Red Winter Wheat</i> <i>Soft Red Winter Wheat</i> <i>Hard White Wheat</i>	<i>DURW</i> <i>SWW</i> <i>HRSW</i> <i>HRWW</i> <i>SRWW</i> <i>HDWW</i>	<i>Two-rowed Barley</i> <i>Six-rowed Barley</i> <i>Oats</i>	<i>TRB</i> <i>SRB</i> <i>OATS</i>
<i>Sunflower Seed (Oil)</i>	<i>SUNF</i>	<i>Long Grain Rough Rice</i> <i>Medium Grain Rough Rice</i>	<i>LGRR</i> <i>MGRR</i>
<i>Grain Sorghum</i>	<i>SORG or</i> <i>MILO</i>	<i>Small Oil Seeds (under consideration)</i>	
<i>[Nonretroactive as of January 1, 1998] (Table Added 1993) (Amended 1995, 1998)</i>			

<i>Table S.2.5. Categories of Device and Methods of Sealing</i>	
<i>Categories of Device</i>	<i>Method of Sealing</i>
<i>Category 1: No remote configuration capability.</i>	<i>Seal by physical seal or two event counters: One for calibration parameters (000 to 999) and one for configuration parameters (000 to 999). If equipped with event counters, the device must be capable of displaying, or printing through the device or through another on-site device, the contents of the counters.</i>
<i>Category 2: Remote configuration capability, but access is controlled by physical hardware.</i> <i>A device shall clearly indicate that it is in the remote configuration mode and shall not be capable of operating in the measure mode while enabled for remote configuration.</i>	<i>The hardware enabling access for remote communication must be at the device and sealed using a physical seal or two event counters; one for calibration parameters (000 to 999) and one for configuration parameters (000 to 999). If equipped with event counters, the device must be capable of displaying, or printing through the device or through another on-site device, the contents of the counters.</i>
<i>Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password).</i> <i>When accessed remotely for the purpose of modifying sealable parameters, the device shall clearly indicate that it is in the configuration mode and shall not be capable of operating in the measuring mode.</i>	<i>An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter (for calibration changes consisting of multiple constants, the calibration version number may be used rather than the calibration constants). A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to twenty-five (25) times the number of sealable parameters in the device, but not more than 1000 records are required. (Note: Does not require 1000 changes to be stored for each parameter.)</i>
<i>Category 3a: No remote capability, but operator is able to make changes that affect the metrological integrity of the device (e.g., slope, bias, etc.) in normal operation.</i>	<i>Same as Category 3.</i>
<i>Category 3b: No remote capability, but access to metrological parameters is controlled through a software switch (e.g., password).</i>	<i>Same as Category 3.</i>

[Table Nonretroactive as of January 1, 1999.] (Amended 1998)

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Sec. 5.56.(b) Grain Moisture Meters

Section 5.56. has been reorganized into two Sections. This Section, 5.56.(b), is applicable to all non-NTEP grain moisture meters manufactured or placed into service before January 1, 1998. (Code reorganized and renumbered 1996.)

A. Application

A.1. This code applies to grain moisture meters; that is, devices used to indicate directly or through conversion and/or correction tables the moisture content of cereal grain and oil seeds. The code consists of general requirements applicable to all moisture meters and specific requirements applicable only to certain types of moisture meters.

A.2. This code does not apply to devices used for in-motion measurement of grain moisture content or seed moisture content.

A.3. See also Sec. 1.10; General Code requirements.

S. Specifications

S.1. Design of Indicating and Recording Elements and of Recorded Representations.

S.1.1. Primary Elements, General. - A meter shall be equipped with a primary indicating element and may also be equipped with a primary recording element. If the meter indicates directly and/or is equipped to record, the meter shall indicate and/or record its measurements in terms of percent moisture content, wet basis. Subdivisions of this unit shall be in terms of decimal subdivisions (not fractions). If the meter indicates in the conventional scale and requires conversion or correction tables, the resulting values after use of such tables shall be in terms of percent moisture content, wet basis. Subdivisions of this unit shall be in terms of decimal subdivisions (not fractions).

S.1.2. Digital Indications.

S.1.2.1. Measurement Completion. - A digital indicating element shall not display any values (either moisture content or conventional scale) before the end of the measurement cycle.

S.1.3. Graduations.

S.1.3.1. Length. - Graduations shall be so varied in length that they may be conveniently read.

S.1.3.2. Width. - In any series of graduations, the width of a graduation shall in no case be greater than the width of the minimum clear interval between graduations, and the width of the main graduations shall be not more than 50 percent greater than the width of subordinate graduations. Graduations shall in no case be less than 0.2 mm (0.008 in) in width.

S.1.3.3. Clear Interval Between Graduations. - The clear interval shall be not less than 0.75 mm (0.03 in) between graduations. If the graduations are not parallel, the measurement shall be made:

- (a) along the line of relative movement between the graduations at the end of the indicator; or
- (b) if the indicator is continuous, at the point of widest separation of the graduations.

S.1.4. Indicators.

S.1.4.1. Symmetry. - The index of an indicator shall be symmetrical with respect to the graduations, at least throughout that portion of its length associated with the graduations.

S.1.4.2. Length. - The index of an indicator shall reach to the finest graduations with which it is used, unless the indicator and the graduations are in the same plane, in which case the distance between the end of the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 1.0 mm (0.04 in).

S.1.4.3. Width. - The width of the index of an indicator in relation to the series of graduations with which it is used shall be not greater than:

- (a) the width of the widest graduation; nor
- (b) the width of the minimum clear interval between graduations.

5.56.(b) Grain Moisture Meters

When the index of an indicator extends along the entire length of a graduation, that portion of the index of the indicator that may be brought into coincidence with the graduation shall be of the same width as the graduation throughout the length of the index that coincides with the graduation.

S.1.4.4. Clearance. - The clearance between the index of an indicator and the graduations shall in no case be more than 1.5 mm (0.06 in).

S.1.4.5. Parallax. - Parallax effects shall be reduced to the practicable minimum.

S.1.5. Recording Elements.

S.1.5.1. General. - If a meter is equipped with a recording element, it shall record in terms of percent moisture content, wet basis only, and not in terms of conventional scale.

S.1.5.2. Measurement Completion. - A recording element shall not record any values before the end of the measurement cycle.

S.1.5.3. Range of Moisture Content. - A recording element shall not record any values when the moisture content of the grain sample is beyond the operating range of the device.

S.1.6. Design of Direct Reading Grain Moisture Meters.

S.1.6.1. Grain or Seed Kind and Class Selection and Recording. - Provision shall be made for selecting and recording, if equipped to record, the kind and class (as appropriate) of grain or seed to be measured. The means to select the kind and class of grain or seed shall be readily visible and the kind and class of grain or seed selected shall be clearly and definitely identified in letters (such as Wheat or WHT, HRWW, etc.).

S.1.6.2. Operating Range. - A meter shall automatically and clearly indicate when the operating range of the meter has been exceeded or the manufacturer shall:

- (a) *clearly and conspicuously mark the operating ranges on the meter; or*
- (b) *furnish the operating ranges of the meter and the means to clearly and conspicuously display this information on or immediately adjacent to the device.*

The operating range shall specify the following:

- (a) *the temperature range over which the meter may be used and still comply with the applicable requirements;*

- (b) *the moisture range for each grain or seed for which the meter is to be used;*
- (c) *the temperature range for each grain or seed for which the meter is to be used; and*
- (d) *the maximum allowable difference in temperature between the meter and the sample for which an accurate moisture determination can be made.*

Examples of clearly indicating these conditions include an error indication, flashing the displayed moisture value, or blanking the display. [Nonretroactive as of January 1, 1989.] (Amended 1986 and 1988)

S.1.6.3. Value of Smallest Unit. - The value of the minimum indicated or recorded moisture indication shall not be greater than 0.1%.
(Amended 2003)

S.1.7. Electric Power Supply.

S.1.7.1. Power Supply, Voltage and Frequency.

- (a) *A meter that operates using alternating current must perform within the tolerances defined in Section T.2. - Tolerance Values over the line voltage range 100 V to 130 V or 200 V to 250 V rms as designed, and over the frequency range of 59.5 Hz to 60.5 Hz.*

- (b) *Battery-operated instruments shall not indicate or record values outside the applicable tolerance limits when battery power output is excessive or deficient. [Nonretroactive as of January 1, 1989.]*

S.1.7.2. Power Interruption. - A power interruption shall not cause an indicating or recording element to display or record any values outside the applicable tolerance limits.
[Nonretroactive as of January 1, 1989.] (Added 1988)

S.1.8. Level Indicating Means. - A meter shall be equipped with a level indicator and leveling adjustments if its performance is changed by an amount greater than the applicable tolerance when the meter is moved from a level position to a position that is out of level in any upright direction by up to 5 percent (approximately 3 degrees).

The level-indicating means shall be readable without removing any meter parts requiring a tool. [Nonretroactive as of January 1, 1989.] (Added 1988) (Amended 1994)

S.1.9. Operating Temperature.

- (a) *A meter shall not display or record any usable values until the operating temperature necessary for accurate determination has been attained, or the meter shall bear a conspicuous statement adjacent to the indication stating that the meter shall be turned on for a time period specified by the manufacturer prior to use.*
- (b) *A meter shall meet the requirements of T.2. - Tolerance Values when operated in the temperature range of 2 °C to 40 °C (35 °F to 104 °F) or within the range specified by the meter manufacturer.*
- (c) *If the manufacturer specifies a temperature range, the range shall be at least 10 °C (20 °F) and shall be marked on the device.*

[Nonretroactive as of January 1, 1989.]

(Added 1988)

S.2. Design of Measuring Elements.

S.2.1. Design of Zero-Setting and Test Point Mechanisms. - If a grain moisture meter is equipped with a zero setting and/or test point mechanism(s), this (these) mechanism(s) shall be adjustable only with a tool outside and entirely separate from this mechanism or enclosed in a cabinet. This requirement shall not apply to manual operations that the operator must make (following operating instructions) in order to obtain a meter reading on a grain sample.

S.2.2. Provision for Sealing. - Provision shall be made for applying a security seal in a manner that requires the security seal to be broken before an adjustment can be made to any component of the grain moisture meter that is set by the manufacturer or authorized service representative and not intended to be adjusted by the user.

S.3. Accessory Equipment. - When the operating instructions for a moisture meter require accessory equipment separate from and external to the moisture meter, such equipment shall be appropriate and complete for the measurement.

S.3.1. Grain-Test Scale. - If the moisture meter requires the weighing of the grain sample, the weighing device shall meet the requirements of the General Code and those applicable portions of the Scales Code.

S.3.2. Thermometers or Other Temperature Sensing Equipment.

- (a) The temperature sensing equipment or thermometer shall be designed to be in direct contact with a grain sample in a closed container. It is acceptable to insert thermometer through a small hole in the lid of the container used to hold the grain sample.
- (b) A separate thermometer or other temperature sensing equipment shall have temperature divisions not greater than the temperature increments used by the manufacturer in the correction table.

(Amended 1988)

S.3.3. Conversion and Correction Tables.

- Conversion and correction tables, charts, graphs, slide rules, or other apparatus to convert the conventional scale values read from a moisture meter to moisture content values, if such apparatus is required, shall be appropriate and correct for the moisture meter being used and shall be marked with the following information:

- (a) name and address or trademark of the manufacturer;
- (b) the type or design of the device with which it is intended to be used;
- (c) date of issue;
- (d) the kind or classes of grain or seed for which the device is designed to measure moisture content;
- (e) the limitations of use, including but not confined to the moisture measurement range, grain or seed temperature, kind or class of grain or seed, moisture meter temperature, voltage and frequency ranges, electromagnetic interferences, and necessary accessory equipment; but
- (f) values exceeding any measurement range shall not be included.

(Added 1984)

S.3.4. Operating Instructions and Use Limitations.

- Operating instructions shall be furnished by the manufacturer with each device with all of the information required by paragraph S.3.3. Complete information concerning the accuracy, sensitivity, and use of accessory equipment (e.g., test weight per bushel equipment, thermometer, etc.) necessary in obtaining a moisture content shall be included.

5.56.(b) Grain Moisture Meters

N. Notes

N.1. Testing Procedures.

N.1.1. Transfer Standards. - Official grain samples shall be used as the official transfer standards with moisture content values assigned by the reference methods. The reference methods shall be the oven drying methods as specified by the USDA GIPSA. Tolerances shall be applied to the average of at least three measurements on each official grain sample. Official grain samples shall be clean and naturally moist, but not tempered (i.e., water not added).
(Amended 1992)

N.1.2. Minimum Test. - A minimum test of a grain moisture meter shall consist of tests:

- (a) with samples (need not exceed three) of each grain or seed for which the device is used, and
 - (b) with samples having at least two different moisture content values within the operating range of the device.
- (Amended 1986, 1989)

N.1.3. Temperature Measuring Equipment. - The accuracy of accessory temperature measuring equipment shall be determined by comparison with a calibrated temperature sensor, such as a total immersion thermometer with 0.1 °C (0.2 °F) sub-divisions, indicating over a range of from 0 °C to 40 °C (32 °F to 104 °F) with a maximum error of ±0.1 °C (0.2 °F). Tests shall be conducted at two temperatures using liquid baths (e.g., ice water and room temperature water). The two temperatures selected shall not exceed the range of temperatures identified in the moisture meter operating instructions.
(Amended 1988)

T. Tolerances¹

T.1. To Underregistration and to Overregistration. - The tolerances hereinafter prescribed shall be applied to errors of under registration and errors of overregistration.

T.2. Tolerance Values. - Maintenance and acceptance tolerances shall be as shown in Table T.2. Tolerances are expressed as a fraction of the percent moisture content of the official grain sample, together with a minimum tolerance.

Table T.2. Acceptance and Maintenance Tolerances For Grain Moisture Meters		
Type of Grain or Seed	Tolerance	Minimum Tolerance
Corn, oats, rice, sorghum, sunflower	0.05 of the percent moisture content	0.8 percent in moisture content
All other cereal grains and oil seeds	0.04 of the percent moisture content	0.7 percent in moisture content

T.3. For Test Weight Per Bushel Devices. - The maintenance and acceptance tolerances on separate test weight per bushel devices used to determine the test weight per bushel of grain samples for the purposes of making density corrections in moisture determination shall be 0.193 kg/hL or 0.15 lb/bu. The test methods used shall be those specified by the USDA GIPSA using a dockage-free sample of dry hard red winter wheat.
(Amended 1992 and 2003)

T.4. Thermometers or Other Temperature Sensing Equipment. - The tolerance for a separate thermometer or temperature sensing equipment used to determine the temperature of grain samples for the purpose of making temperature corrections in moisture determinations shall be ±0.5 °C (1 °F).
(Added 1988)

UR. User Requirements

UR.1. Selection Requirements.

UR.1.1. Value of the Smallest Unit on Primary Indicating and Recording Elements. - The value of the smallest unit on a moisture meter, whether the moisture meter reads directly in terms of moisture content, or when the conventional scale unit is converted or corrected to moisture content, shall be equal to or less than 0.1 percent.

UR.1.2. Environment. - Equipment shall be suitable for the environment in which it is used including, but not limited to, the effects of wind, weather, and RFI.
(Added 2003)

¹ These tolerances do not apply to tests in which grain moisture meters are the transfer standards.

Definitions

The specific code to which the definition applies is shown in [brackets] at the end of the definition. Definitions for the General Code [1.10] apply to all codes in Handbook 44.

A

absolute value. The absolute value of a number is the magnitude of that number without considering the positive or negative sign. [2.20]

acceptance test. The first official test of a farm milk tank, at a particular location, in which the tank is accepted as correct. This test applies to newly constructed tanks, relocated used tanks, and recalibrated tanks. [4.43]

accurate. A piece of equipment is “accurate” when its performance or value—that is, its indications, its deliveries, its recorded representations, or its capacity or actual value, etc., as determined by tests made with suitable standards—conforms to the standard within the applicable tolerances and other performance requirements. Equipment that fails so to conform is “inaccurate.” (Also see “correct.”) [1.10]

analog type. A system of indication or recording in which values are presented as a series of graduations in combination with an indicator, or in which the most sensitive element of an indicating system moves continuously during the operation of the device. [1.10]

animal scale. A scale designed for weighing single heads of livestock. [2.20]
(Amended 1987)

apparent mass versus 8.0 g/cm^3 . The apparent mass of an object versus 8.0 g/cm^3 is the mass of material of density 8.0 g/cm^3 that produces exactly the same balance reading as the object when the comparison is made in air with a density of 1.2 mg/cm^3 at 20°C . [3.30, 3.32]

approval seal. A label, tag, stamped or etched impression, or the like, indicating official approval of a device. (Also see “security seal.”) [1.10]

atmospheric pressure. The average atmospheric pressure agreed to exist at the meter at various ranges of elevation, irrespective of variations in atmospheric pressure from time to time. [3.33]

audit trail. An electronic count and/or information record of the changes to the values of the calibration or configuration parameters of a device. [1.10, 2.20, 3.30]
(Added 1993)

automatic bulk weighing system. A weighing system adapted to the automatic weighing of bulk commodities in successive drafts of predetermined amounts, automatically recording the no-load and loaded weight values and accumulating the net weight of each draft. [2.22]

automatic hopper scale. One adapted to the automatic weighing of bulk commodity in successive drafts of predetermined amounts. (This is not an “automatic-indicating scale” defined below.) [2.20]

automatic-indicating scale. One on which the weights of applied loads of various magnitudes are automatically indicated throughout all or a portion of the weighing range of the scale. (A scale that automatically weighs out commodity in predetermined drafts, such as an automatic hopper scale, a packaging scale, and the like, is not an “automatic-indicating scale.”) [2.20]

automatic temperature or density compensation. The use of integrated or ancillary equipment to obtain from the output of a volumetric meter an equivalent mass, or an equivalent liquid volume at a normal temperature of 70°F and absolute pressure of 14.696 lb/in^2 absolute. [3.34]

automatic zero-setting mechanism. Automatic means provided to maintain zero balance indication without the intervention of an operator. [2.20]

automatic zero-setting mechanism (belt-conveyor scale). A zero setting device that operates automatically without intervention of the operator after the belt has been running empty. [2.21]
(Added 2002)

auxiliary indicator. Any indicator other than the master weight totalizer that indicates the weight of material determined by the scale. [2.21]

axle-load scale. A scale permanently installed in a fixed location, having a load-receiving element specially adapted to determine the combined load of all wheels (1) on a single axle or (2) on a tandem axle of a highway vehicle. [2.20]

Definitions

B

badge. A metal plate affixed to the meter by the manufacturer showing the manufacturer's name, serial number and model number of the meter, and its rated capacity. [3.33]

balance, zero-load. See "zero-load balance." [2.20]

balance indicator. A combination of elements, one or both of which will oscillate with respect to the other, for indicating the balance condition of a nonautomatic indicating scale. The combination may consist of two indicating edges, lines, or points, or a single edge, line, or point and a graduated scale. [2.20]

balancing mechanism. A mechanism (including a balance ball) that is designed for adjusting a scale to an accurate zero-load balance condition. [2.20]

base pressure. The absolute pressure used in defining the gas measurement unit to be used, and is the gauge pressure at the meter plus an agreed atmospheric pressure. [3.33]

basic time rate. The charge for time for all intervals except the initial interval. [5.54]

basic tolerances. Basic tolerances are those tolerances on underregistration and on overregistration, or in excess and in deficiency, that are established by a particular code for a particular device under all normal tests, whether maintenance or acceptance. Basic tolerances include minimum tolerance values when these are specified. Special tolerances, identified as such and pertaining to special tests, are not basic tolerances. [1.10]

basic distance rate. The charge for distance for all intervals except the initial interval. [5.54]

batching meter. A device used for the purpose of measuring quantities of water to be used in a batching operation. [3.36]

beam scale. One on which the weights of loads of various magnitudes are indicated solely by means of one or more weighbeam bars either alone or in combination with counterpoise weights. [2.20]

beam. See "weighbeam." [2.20]

bell prover. A calibrated cylindrical metal tank of the annular type with a scale thereon that, in the downward travel in a surrounding tank containing a sealing medium, displaces air through the meter being proved or calibrated. [3.33]

belt-conveyor. An endless moving belt for transporting material from place to place. [2.21]

belt-conveyor scale. A device that employs a weighing element in contact with a belt to sense the weight of the material being conveyed and the speed (travel) of the material, and integrates these values to produce total delivered weight. [2.21]

belt-conveyor scale systems area. The scale area refers to the scale suspension, weigh idlers attached to the scale suspension, 5 approach (-) idlers, and 5 retreat (+) idlers. [2.21]
(Added 2001)

bench scale. See "counter scale." [2.20]

binary submultiples. Fractional parts obtained by successively dividing by the number 2. Thus, one-half, one fourth, one-eighth, one-sixteenth, and so on, are binary submultiples. [1.10]

built-for-purpose device. Any main device or element which was manufactured with the intent that it be used as, or part of, a weighing or measuring device or system. [1.10]
(Added 2003)

C

calibration parameter. Any adjustable parameter that can affect measurement or performance accuracy and, due to its nature, needs to be updated on an ongoing basis to maintain device accuracy, e.g., span adjustments, linearization factors, and coarse zero adjustments. [2.20, 3.30]
(Added 1993)

car-wash timer. A timer used in conjunction with a coin-operated device to measure the time during which car-wash water, cleaning solutions, or waxing solutions are dispensed. [5.55]

center-reading tank. One so designed that the gauge rod or surface gauge, when properly positioned for use, will be approximately in the vertical axis of the tank, centrally positioned with respect to the tank walls. [4.43]

cereal grain and oil seeds. Agricultural commodities including, but not limited to, corn, wheat, oats, barley, flax, rice, sorghum, soybeans, peanuts, dry beans, safflower, sunflower, fescue seed, etc. [5.56]

chart recorder. See analog or digital recorder.
(Amended 2002)

check rate. A rate of flow usually 20 percent of the capacity rate. [3.33]

checkweighing scale. One used to verify predetermined weight within prescribed limits. [2.20]

class of grain. Hard Red Winter Wheat as distinguished from Hard Red Spring Wheat as distinguished from Soft Red Winter Wheat, etc. [5.56]

clear interval between graduations. The distance between adjacent edges of successive graduations in a series of graduations. If the graduations are “staggered,” the interval shall be measured, if necessary, between a graduation and an extension of the adjacent graduation. (Also see “minimum clear interval.”) [1.10]

cleared. A taximeter is “cleared” when it is inoperative with respect to all fare indication, when no indication of fare or extras is shown and when all parts are in those positions in which they are designed to be when the vehicle on which the taximeter is installed is not engaged by a passenger. [5.54]

cold-tire pressure. The pressure in a tire at ambient temperature. [5.53, 5.54]

computing type or computing type device. A device designed to indicate, in addition to weight or measure, the total money value of product weighed or measured, for one of a series of unit prices. [1.10]

computing scale. One that indicates the money values of amounts of commodity weighed, at predetermined unit prices, throughout all or part of the weighing range of the scale. [2.20]

concave curve. A change in the angle of inclination of a belt conveyor where the center of the curve is above the conveyor. [2.21]

concentrated load capacity (CLC) (also referred to as Dual Tandem Axle Capacity (DTAC)). A capacity rating of a vehicle or axle-load scale, specified by the manufacturer, defining the maximum load applied by a group to two axles with a centerline spaced 4 feet apart and an axle width of 8 feet for which the weighbridge is designed. The concentrated load capacity rating is for both test and use. [2.20] (Added 1988) (Amended 1991, 1994 and 2003)

configuration parameter. Any adjustable or selectable parameter for a device feature that can affect the accuracy of a transaction or can significantly increase the potential for fraudulent use of the device and, due to its nature, needs to be updated only during device installation or upon replacement of a component, e.g., division value (increment), sensor range, and units of measurement. [2.20, 3.30] (Added 1993)

consecutive-car test train. A train consisting of cars weighed on a reference scale, then coupled consecutively and run over the coupled-in-motion railway track scale under test. [2.20] (Added 1990)

construction-material hopper scale. A scale adapted to weighing construction materials such as sand, gravel, cement, and hot oil. [2.20]

contract sale. A sale where a written agreement exists, prior to the point of sale, in which both buyer and seller have accepted pricing conditions of the sale. Examples include, but are not limited to: e-commerce, club sales, or pre-purchase agreements. Any devices used in the determination of quantity must comply with NIST Handbook 44. [3.30, 3.31, 3.37] (Added 1993) (Amended 2002)

conventional scale. If the use of conversion tables is necessary to obtain a moisture content value, the moisture meter indicating scale is called “conventional scale.” The values indicated by the scale are dimensionless. [5.56]

conversion table. Any table, graph, slide rule, or other external device used to determine the moisture content from the value indicated by the moisture meter. [5.56]

correction table. Any table, graph, slide rule, or other external device used to determine the moisture content from the value indicated by the moisture meter when the indicated value is altered by a parameter not automatically corrected for in the moisture meter (for example, temperature or test weight). [5.56]

convex curve. A change in the angle of inclination of a belt conveyor where the center of the curve is below the conveyor. [2.21]

conveyor stringers. Support members for the conveyor on which the scale and idlers are mounted. [2.21]

correct. A piece of equipment is “correct” when, in addition to being accurate, it meets all applicable specification requirements. Equipment that fails to meet any of the requirements for correct equipment is “incorrect.” (Also see “accurate.”) [1.10]

counter scale. One that, by reason of its size, arrangement of parts, and moderate nominal capacity, is adapted for use on a counter or bench. Sometimes called “bench scale.” [2.20]

counterbalance weight. One intended for application near the butt of a weighbeam for zero-load balancing purposes. [2.20]

counterpoise weight. A slotted or “hanger” weight intended for application near the tip of the weighbeam of a scale having a multiple greater than 1. [2.20]

coupled-in-motion railroad weighing system. A device and related installation characteristics consisting of (1) the associated approach trackage, (2) the scale (i.e., the weighing element, the load-receiving element, and the indicating element with its software), and (3) the exit trackage which permit the weighing of railroad cars coupled in motion. [2.20] (Added 1992)

Definitions

crane scale. One with a nominal capacity of 5000 pounds or more designed to weigh loads while they are suspended freely from an overhead, trackmounted crane. [2.20]

cryogenic liquid-measuring device. A system including a liquid-measuring element designed to measure and deliver cryogenic liquids in the liquid state. [3.34]
(Amended 1986 and 2003)

cryogenic liquids. Fluids whose normal boiling point is below 120 kelvin (-243 °F). [3.34]

cubic foot, standard. That quantity of gas that occupies a volume of one cubic foot when under a pressure of 14.73 lb/in² absolute and at a temperature of 60 °F. [3.33]

cubic foot, metered. That quantity of gas that occupies one cubic foot when under pressure and temperature conditions existing in the meter. [3.33]

cubic-foot bottle. A metal bottle open at the lower end and so supported that it may be easily raised or lowered in a tank that contains a sealing medium. With the level of the sealing medium properly adjusted, the bottle, when lowered, will displace exactly one cubic foot of air upon coming to rest on the bottom of the tank. The marks on the bottle defining the cubic foot are the bottom of the lower neck and the gauge mark that partially surrounds the gauge glass in the upper neck. [3.33]

cubic foot, gas. The amount of a cryogenic liquid in the gaseous state at a temperature of 70 °F and under a pressure of 14.696 lb/in² absolute that occupies one cubic foot. (See NTP.) [3.34]

D

dairy-product-test scale. A scale used in determining the moisture content of butter and/or cheese or in determining the butterfat content of milk, cream, or butter. [2.20]

decreasing-load test. A test for automatic-indicating scales only, wherein the performance of the scale is tested as the load is reduced. [2.20]
(Amended 1987)

deficiency. See “excess and deficiency.” [1.10]

digital type. A system of indication or recording of the selector type or one that advances intermittently in which all values are presented digitally, or in numbers. In a digital indicating or recording element, or in digital representation, there are no graduations. [1.10]

direct sale. A sale in which both parties in the transaction are present when the quantity is being determined. An unattended automated or customer-operated weighing or measuring system is considered to represent the device/business owner in transactions involving an unattended device. [1.10]
(Amended 1993)

discharge line. A rigid pipe connected to the outlet of a measuring device. [3.30]
(Added 1987)

discharge hose. A flexible hose connected to the discharge outlet of a measuring device or its discharge line. [3.30]
(Added 1987)

discrimination (of an automatic-indicating scale). The value of the test load on the load-receiving element of the scale that will produce a specified minimum change of the indicated or recorded value on the scale. [2.20]

dispenser. See motor-fuel device. [3.30]

distributed-car test train. A train consisting of cars weighed first on a reference scale, cars coupled consecutively in groups at different locations within the train, then run over the coupled-in-motion railway track scale under test. The groups are typically placed at the front, middle, and rear of the train. [2.20]
(Added 1990)

dry-hose type. A type of device in which it is intended that the discharge hose be completely drained following the mechanical operations involved in each delivery. (See “dry hose.”) [3.30, 3.34]

dry hose. A discharge hose intended to be completely drained at the end of each delivery of product. (See “dry-hose type.”) [3.30, 3.31]
(Amended 2002)

dynamic monorail weighing system. A weighing system which employs hardware or software to compensate for dynamic effects from the load or the system that do not exist in a static weighing, in order to provide a stable indication. Dynamic factors may include shock or impact loading, system vibrations, oscillations, etc., and can occur even when the load is not moving across the load receiving element. [2.20]
(Added 1999)

E

e_{min} (minimum verification scale division). The smallest scale division for which a weighing element complies with the applicable requirements. [2.20, 2.21, 2.24]
(Added 1997)

multi-jet water meter. A water meter in which the moving element takes the form of a multiblade rotor mounted on a vertical spindle within a cylindrical measuring chamber. The liquid enters the measuring chamber through several tangential orifices around the circumference and leaves the measuring chamber through another set of tangential orifices placed at a different level in the measuring chamber. These meters register by recording the revolutions of a rotor set in motion by the force of flowing water striking the blades. [3.36]
(Added 2003)

multi-revolution scale. An automatic-indicating scale having a nominal capacity that is a multiple of the reading-face capacity and that is achieved by more than one complete revolution of the indicator. [2.20]

multiple cell application load cell. A load cell intended for use in a weighing system which incorporates more than one load cell. A multiple cell application load cell is designated with the letter “M” or the term “Multiple.” (See also “single cell application load cell.”) [2.20]
(Added 1999)

multiple of a scale. In general, the multiplying power of the entire system of levers or other basic weighing elements. (On a beam scale, the multiple of the scale is the number of pounds on the load-receiving element that will be counterpoised by 1 pound applied to the tip pivot of the weighbeam.) [2.20]

multiple range scale. A scale having two or more weighing ranges with different maximum capacities and different scale intervals for the same load receptor, each range extending from zero to its maximum capacity. [2.20]
(Added 1995)

multiple-tariff taximeter. One that may be set to calculate fares at any one of two or more rates. [5.54]

multiple. An integral multiple; that is, a result obtained by multiplying by a whole number. (Also see “multiple of a scale.”) [1.10]

N

natural gas. A gaseous fuel, composed primarily of methane, that is suitable for compression and dispensing into a fuel storage container(s) for use as an engine fuel. [3.37]
(Added 1994)

NBP. Normal boiling point of a cryogenic liquid at 14.696 lb/in² absolute. [3.34]

n_{\max} (maximum number of scale divisions). The maximum number of scale divisions for which a main element or load cell complies with the applicable requirements. The maximum number of scale divisions permitted for an installation is limited to the lowest n_{\max} marked on the scale indicating element, weighing element, or load cell. [2.20, 2.21, 2.24]
(Added 1997)

no-load reference value. A positive weight value indication with no load in the load-receiving element (hopper) of the scale. (Used with automatic bulk-weighing systems and certain single draft, manually-operated receiving hopper scales installed below grade and used to receive grain.) [2.20]

nominal capacity. The nominal capacity of a scale is (a) the largest weight indication that can be obtained by the use of all of the reading or recording elements in combination, including the amount represented by any removable weights furnished or ordinarily furnished with the scale, but excluding the amount represented by any extra removable weights not ordinarily furnished with the scale, and excluding also the capacity of any auxiliary weighing attachment not contemplated by the original design of the scale, and excluding any fractional bar with a capacity less than 2-1/2 percent of the sum of the capacities of the remaining reading elements, or (b) the capacity marked on the scale by the manufacturer, whichever is less. (Also see “nominal capacity, batching scale”; “nominal capacity, hopper scale.”) [2.20]

nominal capacity, batching scale. The nominal capacity of a batching scale is the capacity as marked on the scale by the scale manufacturer, or the sum of the products of the volume of each of the individual hoppers, in terms of cubic feet, times the weight per cubic foot of the heaviest material weighed in each hopper, whichever is less. [2.20]

nominal capacity, hopper scale. The nominal capacity of a hopper scale is the capacity as marked on the scale by the scale manufacturer, or the product of the volume of the hopper in bushels or cubic feet times the maximum weight per bushel or cubic foot, as the case may be, of the commodity normally weighed, whichever is less. [2.20]

nominal. Refers to “intended” or “named” or “stated,” as opposed to “actual.” For example, the “nominal” value of something is the value that it is supposed or intended to have, the value that it is claimed or stated to have, or the value by which it is commonly known. Thus, “1-pound weight,” “1-gallon measure,” “1-yard indication,” and “500-pound scale” are statements of nominal values; corresponding actual values may be greater or lesser. (See nominal capacity of a scale.) [1.10]

nonretroactive. “Nonretroactive” requirements are enforceable after the effective date for:

1. devices manufactured within a State after the effective date;
2. both new and used devices brought into a State after the effective date; and
3. devices used in noncommercial applications which are placed into commercial use after the effective date.

Definitions

Nonretroactive requirements are not enforceable with respect to devices that are in commercial service in the State as of the effective date or to new equipment in the stock of a manufacturer or a dealer in the State as of the effective date. (*Nonretroactive requirements are printed in italic type.*) [1.10] (Amended 1989)

nose-iron. A slide-mounted, manually-adjustable pivot assembly for changing the multiple of a lever. [2.20]

notes. A section included in each of a number of codes, containing instructions, pertinent directives, and other specific information pertaining to the testing of devices. Notes are primarily directed to weights and measures officials. [1.10]

NTP density and volume correction factor. A correction factor used to adjust the liquid volume of a cryogenic product at the time of measurement to the gas equivalent at NTP. [3.34]

NTP. Normal temperature of 21 °C (70 °F) and pressure of 101.325 kPa (14.696 lb/in² absolute) respectively. [3.34]

O

odometer. A device that automatically indicates the total distance traveled by a vehicle. For the purpose of this code, this definition includes hub odometers, cable-driven odometers, and the distance-indicating or odometer portions of “speedometer” assemblies for automotive vehicles. [5.53]

official grain samples. Grain or seed used by the official as the official transfer standard from the reference standard method to test the accuracy and precision of grain moisture meters. [5.56]

official with statutory authority. The representative of the jurisdiction(s) responsible for certifying the accuracy of the device. [2.20, 2.21, 2.22] (Added 1991)

operating tire pressure. The pressure in a tire immediately after a vehicle has been driven for at least 5 miles or 8 kilometers. [5.53, 5.54]

over-and-under indicator. An automatic-indicating element incorporated in or attached to a scale and comprising an indicator and a graduated scale with a central or intermediate “zero” graduation and a limited range of weight graduations on either side of the zero graduation, for indicating weights greater than and less than the predetermined values for which other elements of the scale may be set. (A scale having an over-and-under indicator is classed as an automatic-indicating scale.) [2.20]

overregistration and underregistration. When an instrument or device is of such a character that it indicates or records values as a result of its operation, its error is said to be in the direction of overregistration or underregistration, depending upon whether the indications are, respectively, greater or less than they should be. Examples of devices having errors of “overregistration” are: a fabric-measuring device that indicates more than the true length of material passed through it; and a liquid-measuring device that indicates more than the true amount of the liquid delivered by the device. Examples of devices having errors of “underregistration” are: a meter that indicates less than the true amount of product that it delivers; and a weighing scale that indicates or records less than the true weight of the applied load. [1.10]

P

parallax. The apparent displacement, or apparent difference in height or width, of a graduation or other object with respect to a fixed reference, as viewed from different points. [1.10]

parking meter. A coin-operated device for measuring parking time for vehicles. [5.55]

passenger vehicles. Vehicles such as automobiles, recreational vehicles, limousines, ambulances, and hearses. [5.53]

performance requirements. Performance requirements include all tolerance requirements and, in the case of nonautomatic-indicating scales, sensitivity requirements (SR). (See definitions for “tolerance” and “sensitivity requirement”.) [1.10]

point-of-sale system. An assembly of elements including a weighing or measuring element, an indicating element, and a recording element (and may also be equipped with a “scanner”) used to complete a direct sales transaction. [2.20, 3.30, 3.32, 3.37] (Added 1986) (Amended 1997)

poise. A movable weight mounted upon or suspended from a weighbeam bar and used in combination with graduations, and frequently with notches, on the bar to indicate weight values. (A suspended poise is commonly called a “hanging poise”.) [2.20]

postal scale. A scale (usually a computing scale) designed for use to determine shipping weight or delivery charges for letters or parcels delivered by the U.S. Postal Service or private shipping companies. A weight classifier may be used as a postal scale. [2.20] (Added 1987)

prepackaging scale. A computing scale specially designed for putting up packages of random weights in advance of sale. [2.20]

prescription scale. A scale or balance adapted to weighing the ingredients of medicinal and other formulas prescribed by physicians and others and used or intended to be used in the ordinary trade of pharmacists. [2.20]

pressure type (device). A type of device designed for operation with the liquid under artificially produced pressure. [3.30]

primary indicating or recording elements. The term “primary” is applied to those principal indicating (visual) elements and recording elements that are designed to, or may, be used by the operator in the normal commercial use of a device. The term “primary” is applied to any element or elements that may be the determining factor in arriving at the sale representation when the device is used commercially. (Examples of primary elements are the visual indicators for meters or scales not equipped with ticket printers or other recording elements and both the visual indicators and the ticket printers or other recording elements for meters or scales so equipped.) The term “primary” is not applied to such auxiliary elements as, for example, the totalizing register or predetermined-stop mechanism on a meter or the means for producing a running record of successive weighing operations, these elements being supplementary to those that are the determining factors in sales representations of individual deliveries or weights. (See “indicating element” and “recording element”.) [1.10]

prover oil. A light oil of low vapor pressure used as a sealing medium in bell provers, cubic-foot bottles, and portable cubic-foot standards. [3.33]

proving indicator. The test hand or pointer of the proving or leak-test circle on the meter register or index. [3.33]

prover method. A method of testing milk tanks that utilizes approved volumetric prover(s) for measuring the test liquid removed from or introduced into the tank. [4.43]
(Amended 2002)

R

“r” factor. A computation for determining the suitability of a vehicle scale for weighing vehicles with varying axle configurations. The factor was derived by dividing the weights in FHWA Federal Highway Bridge Gross Weight Table B by 34 000 lbs. (The resultant factors contained in Table UR.3.2.1.) [2.20]
(Added 1997)

radio frequency interference (RFI). Radio frequency interference is a type of electrical disturbance that, when introduced into electronic and electrical circuits, may cause deviations from the normally expected performance. [1.10]

ranges, weight. See “weight ranges.” [2.20]

rated scale capacity. That value representing the weight that can be delivered by the device in one hour. [2.21]

rated capacity. The rate of flow in cubic meters per hour of a hydrocarbon gas vapor-measuring device as recommended by the manufacturer. This rate of flow should cause a pressure drop across the meter not exceeding 1/2-inch water column. [3.33]

ratio test. A test to determine the accuracy with which the actual multiple of a scale agrees with its designed multiple. This test is used for scales employing counterpoise weights and is made with standard test weights substituted in all cases for the weights commercially used on the scale. (It is appropriate to use this test for some scales not employing counterpoise weights.) [2.20]

reading-face capacity. The largest value that may be indicated on the reading face, exclusive of the application or addition of any supplemental or accessory elements. [1.10]

reading face. That portion of an automatic-indicating weighing or measuring device that gives a visible indication of the quantity weighed or measured. A reading face may include an indicator and a series of graduations or may present values digitally, and may also provide money-value indications. [1.10]

recorded representation. The printed, embossed, or other representation that is recorded as a quantity by a weighing or measuring device. [1.10]

recording element. An element incorporated in a weighing or measuring device by means of which its performance relative to quantity or money value is permanently recorded on a tape, ticket, card, or the like, in the form of a printed, stamped, punched, or perforated representation. [1.10, 2.21]

recording scale. One on which the weights of applied loads may be permanently recorded on a tape, ticket, card, or the like in the form of a printed, stamped, punched, or perforated representation. [2.20]

reference weight car. A railroad car weighed on a scale for temporary use as a mass standard over a short period of time (typically, the time required to test one scale) as part of a test train.

Note: A test weight car that is representative of the types of cars typically weighed on the scale under test may be used wherever reference weight cars are specified. [2.20]
(Added 1991)

remanufactured device.

[NOT ADOPTED]

remanufactured element.

[NOT ADOPTED]

Definitions

remote configuration capability. The ability to adjust a weighing or measuring device or change its sealable parameters from or through some other device that is not itself necessary to the operation of the weighing or measuring device or is not a permanent part of that device. [2.20, 3.30]
(Added 1993)

repaired devices.

[NOT ADOPTED]

repaired element.

[NOT ADOPTED]

retail device. A device used for:

single deliveries of less than 100 gallons,

retail deliveries of motor fuels to individual highway vehicles, or

single deliveries of liquefied petroleum gas for domestic use and liquified petroleum gas or liquid anhydrous ammonia for nonresale use. [3.32]
(Amended 1987)

retroactive. “Retroactive” requirements are enforceable with respect to all equipment. Retroactive requirements are printed herein in upright Roman type. (Also see “nonretroactive.”) [1.10]

road test. A distance test, over a measured course, of a complete taximeter assembly when installed on a vehicle, the mechanism being actuated as a result of vehicle travel. [5.53]

rolling circumference. The rolling circumference is the straight line distance traveled per revolution of the wheel (or wheels) that actuates the taximeter or odometer. If more than one wheel actuates the taximeter or odometer, the rolling circumference is the average distance traveled per revolution of the actuating wheels. [5.53, 5.54]

S

scale division, number of (n). Quotient of the capacity divided by the value of the verification scale division: [2.20]

$$n = \frac{\text{Capacity}}{e}$$

scale division, value of (d). The value of the scale division, expressed in units of mass, is the smallest subdivision of the scale for analog indication or the difference between two consecutively indicated or printed values for digital indication or printing. (Also see “verification scale division.”) [2.20]

scale section. A part of a vehicle, axle-load, livestock, or railway track scale consisting of two main load supports, usually transverse to the direction in which the load is applied. [2.20]

scale. See specific type of scale. [2.20]

seal. See “approval seal,” “security seal”. [1.10]

section capacity. The section capacity of a scale is the maximum live load that may be divided equally on the load pivots or load cells of a section.
(Added 2001)

section test. A shift test in which the test load is applied over individual sections of the scale. This test is conducted to disclose the weighing performance of individual sections, since scale capacity test loads are not always available and loads weighed are not always distributed evenly over all main load supports. [2.20]

security means. A method used to prevent access by other than qualified personnel, or to indicate that access has been made to certain parts of a scale that affect the performance of the device. [2.21]

security seal. A uniquely identifiable physical seal, such as a lead-and-wire seal or other type of locking seal, a pressure-sensitive seal sufficiently permanent to reveal its removal, or similar apparatus attached to a weighing or measuring device for protection against or indication of access to adjustment. (Also see “approval seal”.) [1.10]
(Amended 1994)

selector-type. A system of indication or recording in which the mechanism selects, by means of a ratchet-and-pawl combination or by other means, one or the other of any two successive values that can be indicated or recorded. [1.10]

semi-automatic zero-setting mechanism. Automatic means provided to attain a direct zero balance indication requiring a single initiation by an operator. [2.20]

sensitivity requirement (SR). A performance requirement for a nonautomatic-indicating scale; specifically, the minimum change in the position of rest of the indicating element or elements of the scale in response to the increase or decrease, by a specified amount, of the test load on the load-receiving element of the scale. [2.20]

sensitivity (of a nonautomatic-indicating scale). The value of the test load on the load-receiving element of the scale that will produce a specified minimum change in the position of rest of the indicating element or elements of the scale. [2.20]

shift test. A test intended to disclose the weighing performance of a scale under off-center loading. [2.20]

side. That portion of a pump or dispenser which faces the consumer during the normal delivery of product. [3.30]
(Added 1987)

simulated-road test. A distance test during which the taximeter or odometer may be actuated by some means other than road travel. The distance traveled is either measured by a properly calibrated roller device or computed from rolling circumference and wheel-turn data. [5.53, 5.54]

simulated test. A test using artificial means of loading the scale to determine the performance of a belt-conveyor scale. [2.21]

single cell application load cell. A load cell intended for use in a weighing system which incorporates one or more load cells. A single cell application load cell is designated with the letter “S” or the term “Single.” (See also “multiple cell application load cell.”) [2.20]
(Added 1999)

single-tariff taximeter. One that calculates fares at a single rate only. [5.54]

skirting. Stationary side boards or sections of belt conveyor attached to the conveyor support frame or other stationary support to prevent the bulk material from falling off the side of the belt. [2.21]

slow-flow meter. A retail device designed for the measurement, at very slow rates (less than 10 gallons per hour), of liquid fuels at individual domestic installations. [3.30]

small-delivery device. Any device other than a large-delivery device. [3.34]

span (structural). The distance between adjoining sections of a scale. [2.20]
(Added 1988)

specification. A requirement usually dealing with the design, construction, or marking of a weighing or measuring device. Specifications are directed primarily to the manufacturers of devices. [1.10]

static monorail weighing system. A weighing system in which the load being applied is stationary during the weighing operation. [2.20]
(Added 1999)

strain-load test. The test of a scale beginning with the scale under load and applying known test weights to determine accuracy over a portion of the weighing range. The scale errors for a strain-load test are the errors observed for the known test loads only. The tolerances to be applied are based on the known test load used for each error that is determined. [2.20, 2.22]

subordinate graduation. Any graduation other than a main graduation. (Also see “graduation”.) [1.10]

subsequent distance or time intervals. The intervals corresponding to money drops following the initial money drop. [5.54]

substitution test. A scale testing process used to quantify the weight of material or objects for use as a known test load. (Added 2003)

substitution test load. The sum of the combination of field standard test weights and any other applied load used in the conduct of a test using substitution test methods. (Added 2003)

surface gauge. A combination of (1) a stationary indicator, and (2) a movable, graduated element designed to be brought into contact with the surface of the liquid from above. [4.43]

T

tail pulley. The pulley at the opposite end of the conveyor from the head pulley. [2.21]

take-up. A device to provide sufficient tension in a conveyor belt so that the belt will be positively driven by the drive pulley. A counter-weighted take-up consists of a pulley free to move in either the vertical or horizontal direction with dead weights applied to the pulley shaft to provide the tension required. [2.21]

tare-weighbeam elements. The combination of a tare bar and its fractional bar, or a tare bar alone if no fractional bar is associated with it. [2.20]

tare mechanism. A mechanism (including a tare bar) designed for determining or balancing out the weight of packaging material, containers, vehicles, or other materials that are not intended to be included in net weight determinations. [2.20]

taximeter. A device that automatically calculates, at a predetermined rate or rates, and indicates the charge for hire of a vehicle. [5.54]

testing. An operation consisting of a series of volumetric determinations made to verify the accuracy of the volume chart that was developed by gauging. [4.43]

test liquid. The liquid used during the test of a device. [3.30]

test chain. A device used for simulated tests consisting of a series of rollers or wheels linked together in such a manner as to assure uniformity of weight and freedom of motion to reduce wear, with consequent loss of weight, to a minimum. [2.21]

test train. A train consisting of or including reference weight cars and used to test coupled-in-motion railway track scales. The reference weight cars may be placed consecutively or distributed in different places within a train. [2.20]
(Added 1990) (Amended 1991)

Definitions

test weight car. A railroad car designed to be a stable mass standard to test railway track scales. The test weight car may be one of the following types: a self-contained composite car, a self-propelled car, or a standard rail car. [2.20]
(Added 1991)

time recorder. A clock-operated mechanism designed to record the time of day. Examples of time recorders are those used in parking garages to record the “in” and “out” time of day for parked vehicles. [5.55]

timing device. A device used to measure the time during which a particular paid-for service is dispensed. Examples of timing devices are laundry driers, car-wash timers, parking meters, and parking-garage clocks and recorders. [5.55]

tolerance. A value fixing the limit of allowable error or departure from true performance or value. (See also “basic tolerances”.) [1.10]

training idlers. Idlers of special design or mounting intended to shift the belt sideways on the conveyor to assure the belt is centered on the conveying idlers. [2.21]

transfer standard. A measurement system designed for use in proving and testing cryogenic liquid-measuring devices. [3.34]

tripper. A device for unloading a belt conveyor at a point between the loading point and the head pulley. [2.21]

U

uncoupled-in-motion railroad weighing system. A device and related installation characteristics consisting of (1) the associated approach trackage, (2) the scale (i.e., the weighing element, the load-receiving element, and the indicating element with its software), and (3) the exit trackage which permit the weighing of railroad cars uncoupled in motion. [2.20]
(Added 1993)

underregistration. See “overregistration” and “under-registration.” [1.10]

unit price. The price at which the product is being sold and expressed in whole units of measurement. [3.30]
(Added 1992)

unit weight. One contained within the housing of an automatic-indicating scale and mechanically applied to and removed from the mechanism. The application of a unit weight will increase the range of automatic indication, normally in increments equal to the reading-face capacity. [2.20]

unit train. A unit train is defined as a number of contiguous cars carrying a single commodity from one consignor to one consignee. The number of cars is determined by agreement among the consignor, consignee, and the operating railroad. [2.20]

user requirement. A requirement dealing with the selection, installation, use, or maintenance of a weighing or measuring device. User requirements are directed primarily to the users of devices. [1.10]

usual and customary. Commonly or ordinarily found in practice or in the normal course of events and in accordance with established practices. [1.10]

V

value of minimum graduated interval. The value represented by the interval from the center of one graduation to the center of the succeeding graduation. Also, the increment between successive recorded values. (Also see “graduated interval”.) [1.10]

vehicle on-board weighing system. A weighing system designed as an integral part of or attached to the frame, chassis, lifting mechanism, or bed of a vehicle, trailer, industrial truck, industrial tractor, or forklift truck. [2.20]
(Amended 1993)

vehicle scale. A scale adapted to weighing highway, farm, or other large industrial vehicles (except railroad freight cars), loaded or unloaded. [2.20]

verification scale division, value of (e). A value, expressed in units of weight (mass) and specified by the manufacturer of a device, by which the tolerance values and the accuracy class applicable to the device are determined. The verification scale division is applied to all scales, in particular to ungraduated devices since they have no graduations. The verification scale division, e, may be different from the displayed scale division, d, for certain other devices used for weight classifying or weighing in predetermined amounts, and certain other Class I and II scales. [2.20]

visible type. A type of device in which the measurement takes place in a see-through glass measuring chamber. [3.30]

v_{\min} (minimum load cell verification interval). The smallest load cell verification interval, *expressed in units of mass** into which the load cell measuring range can be divided. [2.20, 2.21, 2.24]
[*Nonretroactive as of January 1, 2001]
(Added 1996) (Amended 1999)

W

weighbeam. An element comprising one or more bars, equipped with movable poises or means for applying counterpoise weights or both. [2.20]

weighing element. That portion of a scale that supports the load-receiving element and transmits to the indicating element a signal or force resulting from the load applied to the load-receiving element. [2.20]
(Added 1988)